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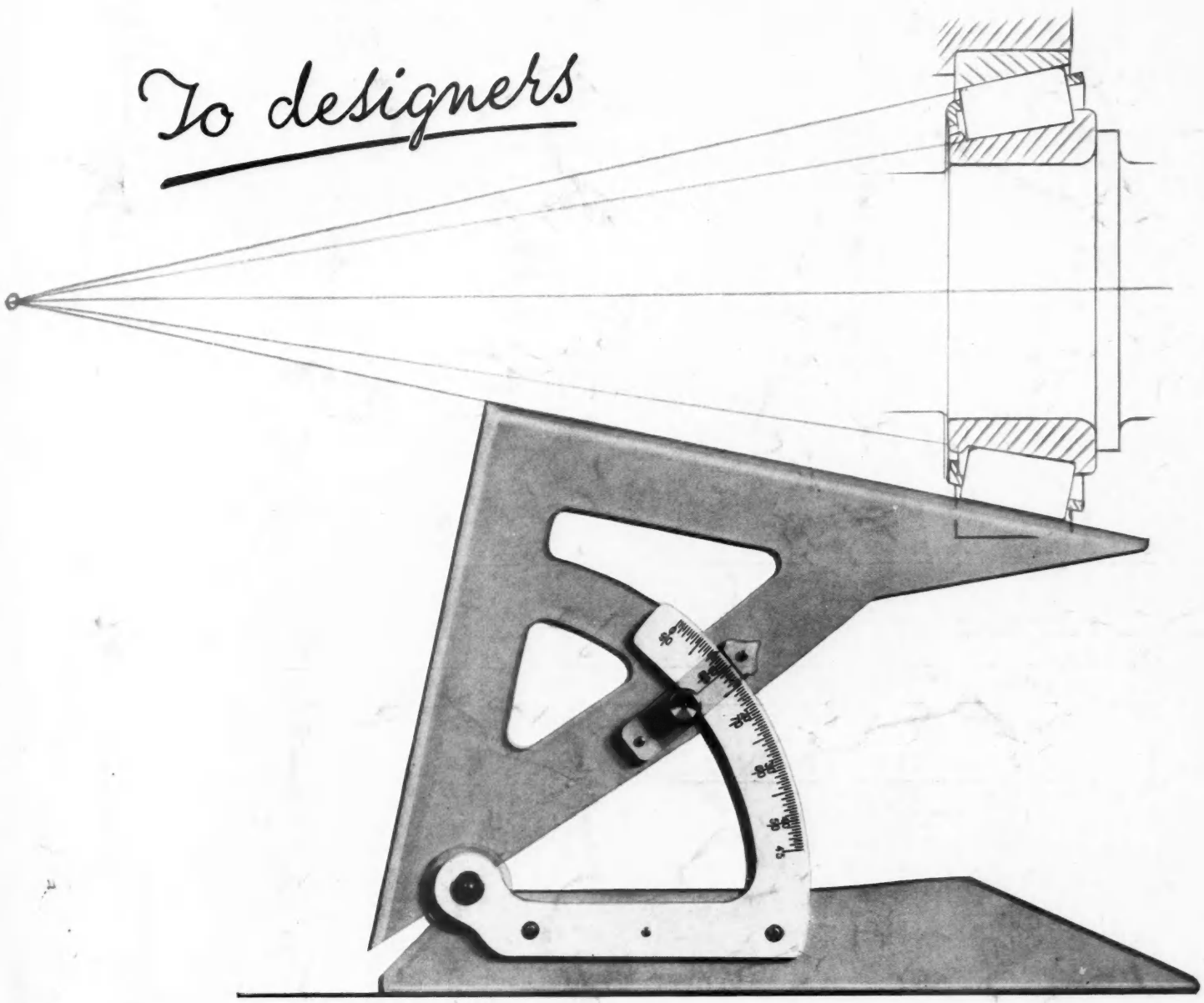
To designers



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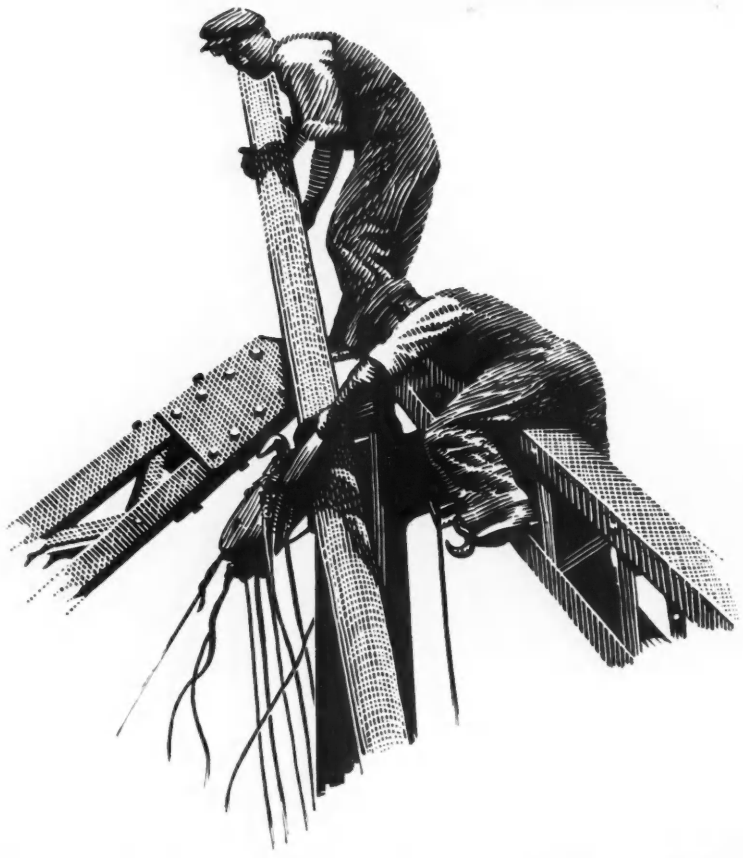

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A Seven-Day Journal

London Passenger Transport Board

REFERENCE has already been made in our columns to the impending retirement of Mr. Frank Pick from the posts of Vice-Chairman and Chief Executive Officer of the London Passenger Transport Board. Although Mr. Pick will retire on Wednesday, May 17th, changes in the Company's organisation consequent upon his retirement have been made and came into effect on Friday of last week, May 3rd. The office of chief executive officer has been abolished, and the work of the Board has now been divided into departments as follows:—Secretary and legal adviser, Mr. C. G. Page; comptroller, Mr. L. C. Hawkins; chief commercial manager, Mr. R. McDonald; general manager (operation), Mr. T. E. Thomas; engineer-in-chief, Mr. V. A. M. Robertson; executive officer for staff and staff welfare, Mr. John Cliff; principal officer (special duties) (attached to chairman's office), Mr. Ivor Fraser. We may recall that Mr. Frank Pick joined the Metropolitan District Railways Company in 1906, and rose to the position of Managing Director of the Underground group of companies. When in 1933 the London Passenger Transport Board was formed Mr. Pick became its Vice-Chairman and Chief Executive Officer, positions which he has continued to hold with great distinction. In his many years of service, numbering over thirty-four, Mr. Pick has played a leading part in the development of London's passenger transport system in all its phases. He has practical knowledge of traffic working, and this, with his administrative skill in the handling of a large organisation, was placed unreservedly at the service of his Board. The Board has placed on record its deep appreciation of his great work and its sincere regret at the loss of a valued colleague.

Increased Benzole Production Required

ON Thursday, May 2nd, Mr. Geoffrey Lloyd, the Secretary for Mines, issued an appeal to all owners of gas-works and coke-oven plants, of which there are more than 1100 in Great Britain, to mobilise all their resources in the production of substitutes for imported fuels. Mr. Lloyd stated that the Government had accepted the report of the committee which he had set up to investigate the possibility of increasing the amount of liquid products obtained by high-temperature carbonisation, and the most advantageous means of utilising such products in wartime. We understand that the report itself will not be published, because it contains much confidential information which might be of value to the enemy. The report, Mr. Lloyd stated, shows that a great deal of work has been done recently to increase the quantity of benzole recovered, for it is estimated that 15,000,000 more gallons of crude benzole will be recovered this year than in 1938. The committee is of opinion, however, that a further quantity of crude benzole, amounting to some 12,000,000 gallons in a normal year, could be reasonably recovered at gas-works and coke oven plants. In the course of his presidential address which was delivered at the meeting of the North of England Gas Managers' Association held at Newcastle-upon-Tyne on Friday, May 3rd, Mr. T. Law, of Malton, said that the Government had requested that all gas-works using 5000 tons of coal or more a year should instal benzole plants for the recovery of wartime benzole. With regard to the price of gas, Mr. Law said that if the public was to have the advantage of cheap gas it was essential that the price of coal should not continue to increase, as it had done during the past five years. Since 1935 there had been an increase of five to seven shillings per ton.

The N.P.L. in Wartime

THE Report for the year 1939 of the National Physical Laboratory states that although the laboratory is carrying out much war work, there has been no need, in view of the facilities for war research elsewhere, to convert it entirely to a war footing. It has therefore been possible for it to continue to fulfil its main function of assisting industry in solving new problems presented by war-time production. The report indicates that the Laboratory has been carrying out important work in almost every direction in which physical and engineering research can aid industry, although for obvious reasons many of the results are not given in detail. Reference is made in the report to investigations on materials which can stand up to high temperatures, and on the behaviour of bolted joints in pipes carrying high pressure steam. From this latter work it is now possible to estimate the life of the joints and the effect of successive re-tightenings. Other work deals with the strength of cylinders for storing and transporting compressed gases, and with the strength of stiffened sheet construction for aircraft and other purposes. Another subject of study has been the light alloys of aluminium and magnesium. Many researches have been carried out on the application of X-rays to the understanding of the internal structure of metals, and optical methods have been developed for measuring the surface finish of metals. The Radio Department has continued to assist the radio-communication industry with its studies of the production and propagation of wireless waves, most attention having been devoted to the ultra-short waves below 10 m. The Aero-dynamics Department has made good progress with its investigations with the object of improving aircraft performance, and the facilities available for this work are being increased by the provision of new wind tunnels. The introduction of the "black-out" brought many new problems to the Photometry Division, and work has been done on the transmission of light through textiles, shielding of lights, and the measurement of very low intensities of illumination.

The Severn Catchment Board

AT a meeting of the Severn Catchment Board, which took place at Worcester on Friday, May 3rd, a report was presented by the engineer, Mr. A. Barton, on the severe damage to the river embankments below Gloucester, which had been caused by the severe frosts and snowstorms which occurred last winter. It will be a long time before the extensive damage can be made good. The record flooding of the River Severn, would alone, Mr. Barton stated, have caused a fair amount of damage to the softened banks, but the vast masses of ice which passed down the river in the first days of the flood literally tore the banks to pieces. When the flooding had subsided it was found that there was scarcely a yard of bank between Gloucester and Longney which had not suffered damage. Examination since made of the sea walls shows that extensive works will be necessary to put them into repair. In the Minsterworth and Elmore reaches whole lengths of the banks have had to be reconstructed, and in many cases it will be necessary to construct new banks set back from the original line. It was satisfactory to learn that no damage had been done to the stone pitching work carried out during the last two years. The question of stone-pitching other sections of the banks in the tidal reaches was discussed. The Chairman of the Board, Mr. T. C. Ward, expressed his deep concern at the enormous cost of maintaining the river banks below Gloucester. More than a year would be required to restore the banks to the state they were in previous to the bad weather. He felt that the grant which the Board had obtained for the tidal waters was inadequate. As far as he could see there would never be any finality to the work on the banks below Gloucester, which took all the money the Board could raise by way of precept. When the war was over and things again returned to normal it would be necessary for the Board to press for a more generous grant from the Government for the tidal reaches of the river.

Proposed Argentine-Bolivian Railway

ACCORDING to a report of the United States Department of Commerce, a provisional agreement signed recently by the Ministers for Foreign Affairs of Argentina and Bolivia defines the basis for the construction of a proposed railway between Yacuiba and Santa Cruz de la Sierra and the exploitation of Bolivian oil fields in conjunction with the Argentine Government. Under its provisions Argentina will advance the funds necessary for the construction of the first section of railway line from the Argentine–Bolivian frontier to Villa Montes, about 62 miles, to be extended later to Santa Cruz de la Sierra. Following the signature of the formal treaty tenders will be called for and the construction of this first section will commence, to be completed within a year. The same agreement provides that the Argentine Government will advance up to 500,000 pesos for boring new wells in the Sanandita oil fields and also undertake to build a pipe line from the Bolivian oil fields in the Bermejo Zone to Oran, in the Argentine Province of Salta. The cost of the first section of the railway is to be paid from the yield of the oil fields in question and the construction of subsequent sections will depend on the extent of the output. The railway is to be operated exclusively by the Bolivian Government.

The British Acetylene Association

THE 39th annual luncheon of the British Acetylene Association was held on Thursday, May 2nd, at the Grosvenor Hotel, Victoria, S.W.1, under the chairmanship of the President, Major C. P. N. Raikes. There was a good attendance of between sixty and seventy members and guests. The toast of "The Guests" was entrusted to Mr. W. W. Watt, who said that the Association was a small one, which co-operated very closely with the various Government Departments and industry. He was proud to say that it functioned more or less without any control. Trade transactions were being conducted on ordinary lines, and there were no difficulties with regard to the supply and delivery of carbide, while there was a wealth of technical service at the disposal of the industry. Mr. W. J. U. Woolcock replied for the guests. The toast of "The British Acetylene Association and its President" was proposed by Mr. H. L. Mussett, who spoke in the unavoidable absence of Mr. J. Abady, K.C. He referred to the good work of the Association and its Presidents during its 39 years, and spoke of its great influence in the trade, which, he said, was recognised in all parts of the world. In his reply, Major Raikes said that his Council had decided that, in spite of the war, they would keep things going, and that the informal luncheon spoke for itself in its good attendance. With regard to oxygen production, tribute should be paid to those who in the years just passed had spent vast sums of money in putting down large plants all over the country. As to acetylene we were perhaps not so fortunate, as we were dependent on a product which was not even made in this country. Again fore-thought had been shown, and we had been able to build up large stocks of carbide in this country which were of the greatest possible value. Though the unfortunate position in Scandinavia had naturally made the position even more difficult, there was nothing to worry about for the present. Major Raikes, who has accepted the office of President for a further year, said that he could assure those present that the Association was going to last out the war, and would have many useful years of life after-wards.

Controller of Light Alloys

THE Air Ministry announces that in order to strengthen the arrangements for the control of the light alloy materials required for the manufacture of aircraft, the Rt. Hon. Sir Samuel Hoare, the Secretary of State for Air, has appointed Brigadier-General H. A. Jones to be Controller of Light Alloys. Concurrently with this appointment, powers are being taken by the Secretary of State under the Defence Regulations to control the fabrication and distribution of light alloys, and to take such other steps as may be necessary to make the control effective. Brigadier-General Jones will take up his duties, which will be whole time, at an early date. He will have the assistance of an Advisory Committee which will include Mr. H. W. Clarke, Mr. W. C. Devereux, Mr. F. S. Mitman, and Mr. P. Pritchard, who have up to the present acted as voluntary part-time controllers of light alloys. The headquarters of the new control will be situated in the Midlands. Brigadier-General Jones served with distinction on the staffs of Field Marshal Lord Haig and Sir William Robertson during the Great War and occupied the post of Deputy Quartermaster-General (Home Forces). After the war he joined the Imperial Tobacco Company and is now a director. He has thus had considerable experience of the problems of large-scale organisation. He served last year as chairman of a committee appointed by the Secretary of State to review the system of Royal Air Force administration.

The Unemployment Returns

THERE was a further substantial improvement in employment between March 11th and April 15th. Between these two dates the number of unemployed persons on the registers of employment exchanges in Great Britain fell by 148,578 and the total of 972,695 registered on April 15th is the lowest recorded since the end of 1920, when the extended unemployment insurance scheme came into operation. Between April 17th, 1939, and April 15th, 1940, there was a reduction of 671,699. The reduction in unemployment between March and April, 1940, was distributed over nearly all the principal industries, the greatest reductions occurring in building and public works contracting, the distributive trades and agriculture. There were also substantial decreases in hotel and boarding-house service, coal mining, engineering, metal goods manufacture, furniture manufacture, printing and bookbinding, local government service, dock, harbour, &c. service, road transport, and brick and tile manufacture. The most marked changes, as compared with the corresponding period ended April 17th, 1939, were, as is to be expected, in the coal mining and engineering and allied industries. Some typical decreases in unemployment, in comparison with April 17th, 1939, are as follows:—Coal mining, 61,746; cotton, 46,068; building, 45,283; public works contracting, 44,439; engineering, 39,155; metal goods manufacture, 27,548; shipbuilding and repairing, 25,532; road transport, 15,966; iron and steel, 13,925; dock, harbour, &c., service, 12,014.

Turbine Locomotive Experiences

By EDWARD H. LIVESAY

No. IV

(*Continued from page* 411, *May* 3rd)

RUGBY TO TRING

DURING the high speed approach to Rugby I had again been giving attention to riding and track reactions of "No. 6202." They were good, as is the general rule with the L.M.S. "Pacifics." She entered curves sympathetically, without the preliminary lurch that one sometimes notices on other types, particularly when the running-gear is not in the best of shape. One engine I sampled in Scotland excelled in this objectionable trick—I took a positive dislike to her. Every bend was hit with a bang and a lurch that swept me off my feet if I was not ready for it, until in sheer self-defence I formed the habit of watching for them, prepared to grab anything solid within reach. I got the fireman once. He proved not to have enough stability, but luckily he did have a sense of humour—a very comforting substitute under the undignifying circumstances that immediately arose. On that engine, whenever I saw a curve coming, I acted like the optimistic Irishman who fell off the roof of a sky-scraper; he said his prayers all the way down, until he saw the terminus approaching, when he sighed, "And now, Pat, get ready for the bump." I had to get ready for those curves, praying that their arrival would find me anchored to something substantial. I dislike that sort of engine; dignity and equilibrium are both compromised, and one can ill afford to disregard either.

The gradient is upward out of Rugby, at 1 in 202–370, for 4·5 miles to Kilsby tunnel; it was taken on three valves, the speed rising to 55 m.p.h. as we entered the north portal of this fine monument to Stephenson. It is 1·5 miles long, and the ventilating shafts are so generously proportioned that light strikes right down them; it can be seen lying like pools of silver on the metals as they are approached, oases of brightness in the sooty murk. There is a 7 miles descent from the southern exit, down through Welton, to Weedon, which was passed at 80 m.p.h., and we shot through Stowe Hill tunnel like a shell through a gun. Blisworth, 19·5 miles from Rugby, was left behind at 7.59½ p.m., the average speed over this stretch having been 63·3 m.p.h.; the succeeding 8·5 miles to Castlethorpe were covered yet a little faster, at 68. Down the descent to Castlethorpe troughs the indicator showed 83 m.p.h., when the brakes went on a little, preparatory to picking up water at about 60. Wolverton, just after, was passed at 8.08 p.m.; here I noted the speed was 75 m.p.h., with three valves in action. Ever since leaving Crewe we had been travelling quite fast, frequently at 75–80 m.p.h., trying to make up the lost time, but I felt it was impossible. Bletchley passed, I began to think about Linslade tunnel, which we were rapidly closing. There are tunnels and tunnels, pleasant and unpleasant. Kilsby comes into the former category; it is high and well-ventilated, but Linslade is a little beast. It is short, and far from sweet. If you are wise, you shut your mouth and eyes before plunging into it, and take care that you do not remove the black-out too soon. I have been caught napping by Linslade before—this time I got ready as soon as "th' imminent deadly breach" appeared in the distance. Polonius's advice to Laertes occurred to me, and I saw that it was good—when slightly altered to fit: "Beware of entrance to a tunnel, but being in bear't that the damn'd thing do not get thee down." A wise saw when applied to this modern instance! So with eyes and mouth tightly shut, and a sweat-rag held over my face, I was advanced to the attack, to be at once engulfed in a thundering inferno of heat and sulphurous smoke. Positioned thus, all sense of poise and direction was lost—I felt like a disembodied spirit hurtling through a suffocating drain. It was possible to sympathise with, and understand the error of the inebriate who went to his window to judge of the night, but like me, losing his sense of direction, he put his head into a cupboard by mistake. The verdict was: "It's hellish dark, and smells of cheese." Linslade is hellish hot, and smells of soot. In fact, it is possible to imagine oneself in another place altogether, one not to be mentioned in a drawing-room, reputedly and probably even more unpleasant, which by care and diplomacy I personally hope to avoid.

TRING TO EUSTON

The long but easy rise to Tring begins just after Linslade; it was taken fast, on three valves, and the sand-gun—soot-blower is another name for it—was used while going up. It is not advisable to turn this on when running through a station—somebody would be sure to complain. Tring was passed at 8.25 p.m., 15 mins. late.; after this point, it is practically downhill or level throughout the succeeding 32 miles into Euston. All further effort on "No. 6202"'s part was unnecessary, and on the enginemen's, too; we were several minutes late, and there was evidently going to be no chance of getting back on to schedule. It was quite dark by this time, and, as usual, I found it impossible to take any worth-while notes of times and speeds thus hampered. Some place would flash by, vaguely outlined and spangled with lights. I would try to get the name, and clock it, but by the time I had puzzled out the combined problem, we were generally thundering through the next station. I did manage to nail Watford down at 8.37 p.m., and Willesden, 8.46 p.m.—one could not very well mistake that little hamlet! After that, we were checked more than once, and nearly brought to a standstill passing Camden, coming to a final stop in Euston at 8.55 p.m., 15 mins. late. The distance of 193·5 miles from Liverpool had been covered in 207 mins., with two stops, and upwards of a dozen checks, so the average speed of practically 56 m.p.h. was decidedly good; much higher than it had appeared to be on the engine. "No. 6202" is very deceptive, to an extent that I never realised until now, as I write this article. I have only just realised that she covered the 116 miles from Lichfield to London in 104 mins., at an average speed of approximately 67 m.p.h., only 3 mins. longer than "Duchess of Hamilton" took with the "Coronation Scot," as described in THE ENGINEER of November 17th last, and with a load 125 tons heavier. It is not fair to go farther back than Lichfield, as "No. 6202" was interfered with several times up to that point; only after Lichfield did she get a clear road. From Rugby the comparison is even more striking, there being only ½ minute in the "Scot's" favour—73½ mins. against "6202"'s 74, for the 82·5 miles; average also nearly 67 m.p.h. And now, going still farther south, I find that from Wolverton to London, 52·5 miles, "6202" *beat* the "Coronation Scot"! The latter took 49 mins., and "6202" only 47. "Peak" speeds are also in her favour—the "Coronation Scot" reached 80 m.p.h., "No. 6202," 83. I am quite ashamed of myself; during all these weeks subsequent to the runs I have failed to do her justice. I have been thinking of her performances as undistinguished, whereas they were really very creditable. But I see now how this came about; I was misled by the 15 mins. late arrival at Euston into overlooking both what had caused it, and the fine work done from, say, Stafford south. I trust "No. 6202" will accept these apologies, and the assurance that I have a warm corner in my heart for her. A fine locomotive always affects me like this—when I get down out of the cab, I feel a sense of separation—in fact, that "parting is such sweet sorrow!" "No. 6202" upset me in this way. I remember another locomotive doing so, too, and being betrayed by my feelings into admitting it; the resulting laugh was on me. I had been delving into the inmost recesses of a fine roller-bearing New York Central "Hudson" at the Harmon Sheds, after which I said to the official who was with me that I should like to take it with me to England as a souvenir. "Sorry we can't let you do that, Mr. Livesay," he said, musingly. "If you want to make a pet of a locomotive, you had better wait until you get to the Old Country, and pick up one of your little fellows. Then you can hang it on your watch-chain." Feeling that the joke had drifted rather too far in my American friend's direction I broke off the engagement at this point, and retired discreetly from the field, minus my souvenir. I am still without a pet locomotive, and my watch-chain remains unencumbered—"No. 6202" would be a welcome attachment to it, however.

"NO. 6202" AND THE "ROYAL SCOT"

The two runs which I have described were very interesting indeed, but it will be admitted that they were not of a nature to stress the engine seriously, or bring out its possibilities fully. Further, as I was only equipped with a note-book and an enquiring mind, I naturally cannot give the reader details needing the assistance of a dynamometer-car. Mr. Stanier has very kindly come to the rescue with the following tables, which give full particulars of two more runs, made by "No. 6202" when she was hauling "The Royal Scot," a task that gave her more scope to demonstrate her powers. The distance covered was twice as great as on my trips, the load was heavier, and the average speed somewhat higher. The maximum speed attained was, it will be noted, 85 m.p.h.; during my runs it was 83 m.p.h. The coal-consumption figures are particularly informative, and show that, at any rate on these two occasions, it was certainly very moderate. It proves conclusively what great advances have been made in locomotive design during recent years, resulting in an economy of fuel for which the superheater is probably chiefly responsible. Without it, in the old days, the coal-consumption probably would have been 50 per cent. higher had, say, a non-superheater "Atlantic" or 4–6–0 been employed on these two runs.

Two Runs with "The Royal Scot."

	Euston–Glasgow	Glasgow-Euston
Date	June 24th	June 25th
Train	10.0 a.m.	10.0 a.m.
Weight of engine, coal and water (tons)	152·0	152·0
Weight of train behind drawbar (tons)	489 ex Euston 320 ex Symington	483
Train Miles	402·24	402·31
Ton miles:		
Excluding weight of engine	190,702	194,316
Including weight of engine	251,838	255,452
Time:		
Actual running minutes	436·5	432·6
Including stops minutes	445·16	435·9
Speed:		
Average m.p.h.	55·25	55·7
Maximum m.p.h.	85·0	81·0
Work done:		
Horse power minutes	374,593·5	357,455·25
Horse power hours	6243·225	5957·6
Horse power minutes/ton mile (excluding engine)	1·97	1·84
Coal:		
Total weight lb.	17,084	16,156
Lb. per mile	42·4	40·2
Lb. per ton mile (excluding engine)	0·0895	0·083
Lb. per ton mile (including engine)	0·0678	0·063
Lb. per D.B.H.P. hour	2·735	2·71
Lb. per sq. ft. of grate area per hour	52·2	49·8
Water:		
Total gallons	15,155	14,420
Gallons per mile	37·7	35·9
Lb. per ton mile (including engine)	0·602	0·565
Lb. per D.B.H.P. hour	24·3	24·2
Evaporation:		
Lb. of water per lb. of coal	8·87	8·92

SUMMING-UP

The chief features of "No. 6202," and the engine's performances under everyday running conditions, have now been dealt with; the conclusion of the account can fittingly take the shape of an appreciative summing-up, and perhaps, as an interested observer, I may also be allowed to say what judgment I am inclined to pass on the machine and its work. There is, however, one important qualification that must be borne in mind before anything in the nature of criticism is attempted, and that is—the engine is an experiment. It represents a bold and most deserving excursion into a little explored field; in fact, in some degree, an unexplored one, as the design differs in important respects from any turbine locomotive hitherto built. It follows that answers to many questions and problems associated with the engine can only be given after lengthy operation in ordinary service; and another point worth remembering is that as little risk of failure as possible has been incurred, and the cost of construction reduced, by grafting, as it were, turbine drive on to an already existing design, the "Princess Royal" class. It is not as though the engine were an entirely original conception throughout; if it were so, this would presumably have resulted in increased possibility of trouble, and certainly in greater cost. The reciprocating locomotive has had a long life, and continuous development; it is simple, reliable, and flexible; it is efficient at low speeds, and is easy to handle. Without

sacrificing its simplicity it is difficult to see how it can be much further improved; additional complication inevitably increases its cost, and may more than offset the gain in mechanical results. Theoretically, the turbine locomotive might show advantages in the constant search for improved designs, and so experiments with it are worth while.

The reciprocating engine becomes more inefficient as its speed rises, due to throttling in the passages leading to and from the cylinders, but with the turbine, full pressure can be maintained in the steam chest at all speeds—presupposing, in this case, that the engine is being run at powers corresponding to the six valves provided on "No. 6202." If it is not, there will be inefficiency in the turbine. I have been told that it is very severe on a turbine to admit high temperature steam when it is stalled, and as this is the position when a turbine locomotive is starting, the running clearances perhaps are made larger than would be necessary in stationary or marine practice, to allow for temperature distortion, so probably this decreases the efficiency slightly. I do not know if this is allowed for on "No. 6202"—I did not raise the point.

With a reciprocating engine, full expansion can only be obtained at short cut-offs, whereas a turbine can utilise full expansion at all speeds, the only limitation being the necessity for having some terminal pressure for blast-purposes. This need only be two or three pounds, and the continuous exhaust of the turbine would, I presume, make it possible to work with a lower exhaust pressure than would be the case with a reciprocating engine, yet still have adequate draught. The blast on "No. 6202" was noticeably very soft—Fireman Jones was of the opinion that it was *too* soft, and surely he ought to be a good judge! I have read that in bygone days enginemen used to fix a spanner or some such intensifier in the blast-pipe when an engine would not steam freely. Dare I mention this to Jones? I am almost afraid to—it might get sucked backwards into the turbine if he took my suggestion to heart, and then both of us would get into trouble!

Superficial criticism will at once stress the absence of a condenser, but a little consideration will relegate this objection to its rightful place in the scheme of things, where it would not necessarily be very prominent. Because a condenser would certainly be employed in stationary or marine practice, it is no argument to claim that it is equally essential and desirable on a locomotive, where space and weight are both at a premium. There would be advantages, of course, but there would be equally obvious drawbacks, and only experience can make it possible to strike a balance between the two. Some economy in fuel consumption would be certain to accrue, but if this were offset by considerably greater first cost and maintenance charges, as would probably be the case, and if in addition there were other incidental handicaps, the saving might well prove to be only a mirage. For instance, the only suitable place for the condenser would be on the tender, which would need to be lengthened considerably, necessitating larger turntables; vibration would also possibly cause trouble. The reduction of scale-formation due to the closed circuit would be a desideratum, resulting in longer periods between washing-out, but as water-softeners are installed throughout the L.M.S.R. mainline, and continuous blow-down valves are fitted to the company's modern engines, this advantage might not amount to very much in practice, when pro and con were balanced. Again, a locomotive boiler calls for forced draught; if this were non-existent, additional apparatus would have to be provided in lieu, and steam used to work it. Finally, a condenser could always be added later, if it were considered worth trying; meanwhile, the designer would be doing wisely in adopting the simplest plan first. He might well act on the precept:

> "Mine not to see the distant view;
> One step enough for me!"

One of the chief reasons that led to the construction of this engine was the expectation that, in spite of the absence of a condenser, economy in fuel consumption would result. I am not in a position to say whether this has been achieved or not. Merely watching the firemen, and listening to their remarks, even though they were couched in the argot of the tribe, and expressed with all the forthright fluency that adds so much to the enjoyment of foot-plate travel, did not constitute a sufficiently accurate means of gauging consumption. Very interesting and often amusing, but liable to lead to false conclusions! During my runs, I naturally had no means of accurately measuring the coal used, but Mr. Stanier has kindly filled the omission, and the figures dealing with "No. 6202"'s runs with "The Royal Scot," on page 430 show very clearly that her consumption, to say the least, is anything but excessive. To handle trains weighing nearly 500 tons between London and Glasgow at an average speed of over 55 m.p.h., with a coal expenditure of only 42·4 lb. and 40·2 lb. per mile on the respective trips, seems to me exceedingly good; I should think the consumption must be little, if at all, heavier than would be the case with a "Coronation." Whether it is *less* than a "Coronation" I cannot say; nor whether the anticipated 15 per cent. economy theoretically looked for has been attained in practice.

Another attribute that it was hoped "No. 6202" would show was availability; that is to say that it would be found available for duty when required more consistently than the reciprocating type of engine; that it would be more reliable, and require less shop and shed attention. I have had the most categorical assurance from people who are in a position to know the facts that this expectation has been realised. Once the "teething troubles" that are invariably met with in a new design were overcome—difficulties which were all the more naturally to be looked for in such a novel machine as this—the engine has since shown unusual reliability. It gives very little trouble, and needs far less "tittivating" than its reciprocating sisters. I was also told that the smoothness of running of the turbine engine shown up in the fact that piping, utilised for various purposes, lasts considerably longer than usual; that things do not shake loose to the same extent as in the normal type; and that the roller-bearings found on all the axles have given no trouble whatever. Approximately 300,000 miles have been covered thus far; this alone speaks well for the design.

During my runs on "No. 6202" I tried to notice as many things as possible, but now I come to write the story I am ashamed to find there was one glaring omission—I apparently disregarded the steam-temperature gauge entirely. I console myself by recalling that even Homer was known to nod. The superheat can be higher on a turbine than on a reciprocating engine. In the latter it is limited by undue wear of sliding mechanism, by difficulties with packing, lubrication, &c., whereas the former does not suffer from such drawbacks. "No. 6202" is designed to work with steam at 750 deg., and probably did so—I do not suppose that she misbehaved in any way. While on the subject of steam, it may be interesting to note that at starting, a turbine can use more steam in a given distance than a reciprocating engine of the same power, because the latter's steam-consumption is governed, amongst other things—such as cut-off—by the number of strokes made while covering that distance, whereas the turbine can have all its nozzles in action, and is not concerned with cut-off. If the boiler can supply this quantity of steam without much initial drop in pressure, one would think the turbine engine should get away quicker. No special effort was made to do this on the occasions when I was with "No. 6202," so I had no opportunity of testing the truth of this theory, and as it is one that needs considerable thought—which I admit I have not given it—I had better not chance my arm any further! All I can assert without shadow of peradventure is that she got away excellently, without a trace of slipping, and that the boiler continued to supply all the steam needed! But I wish I had not overlooked that temperature gauge.

The starting of "No. 6202" brings another picture before my mind's eye—a little boy on the departure platform at Euston, utterly absorbed in the determined struggles of a coal-black engine to take a train to Scotland, in spite of the fact that its two pairs of driving-wheels were revolving in opposite directions. The little boy was myself—the engine was a Webb compound. I remember clearly my puzzled consternation, and the questioning of my immature mind: "Why does it do that? There must be something wrong with it!" The passing of the years, and—I like to think—increased reasoning ability have not led me to revise my childish conclusion—there *was*! They were curious engines, and did queer things, bringing the grey hairs of many a driver in sorrow to a premature grave. The picture fades; let us return to pleasanter subjects, such as the gearing of "No. 6202."

Figs. 5 (*ante*) and 13 show what a beautiful piece of work this is, and make it easy to understand that on the efficient working of the gear-train, and the alignment of the shafts, much of the success or otherwise of a turbine engine must depend. The cost of the gearing is great; thorough lubrication and protection from grit and dust are essential if long life is to be attained. Fig. 6 (*ante*) shows how the quill-drive allows for the movement of the driving-axle. The working of the gear-train was quite unobtrusive on "No. 6202," only the slight hum I referred to giving proof of its existence.

FIG. 13—GEARING OF TURBINE LOCOMOTIVE NO. 6202

It would be possible to mention many other points of interest about this engine, but space prevents it. I have made no secret of the fact that "No. 6202" appealed to me considerably as a very fascinating machine, for which I could easily form an attachment. Fitters Whiston and Parker had evidently fallen under its spell; their loyalty was quite touching! The enginemen had no vital complaints on any score—or if they had, they kept them dark. Fireman Ruffell had such an easy time of it going north that he could not possibly have been anything but satisfied; but I gathered that Jones would have been a trifle happier had there been some means of intensifying the blast, when causes beyond his control found him struggling with a pressure 90 lb. below the proper figure. Naturally—we are not all Mark Tapleys!

My criticisms are very brief—I have none. The riding was good, acceleration quite up to normal, attained without a trace of slipping, which was no doubt the outcome of the constant, unvarying torque. The running was deceptively smooth and quiet, and it was very easy to underestimate the speed. It is evidently equally deceptive to an onlooker; platelayers have been known to sing out: "Here comes the Ghost Train!" when "No. 6202" looms up in the distance. It is a graceful machine in action; only a single-driver locomotive with inside cylinders

could give it points in this respect, and alas! we shall never see the like of that design again. Its day is done.

So ends the account of my turbomotive experiences. I have travelled on many interesting engines lately, from a 350-ton 2–10–4 awaking thunder in the Rockies, to a 60-year-old veteran 0–4–2 slipping through the lush fields of Kent. All have a place in my regard—with one diabolical exception!—but none was quite so intriguing as this unusual machine, "No. 6202." I wish her well, and shall watch her subsequent career with interest.

In conclusion, I am greatly indebted to Mr. Stanier, Chief Mechanical Engineer of the L.M.S.R., and to Messrs. Metropolitan-Vickers, for information, drawings and other material without which the article could not have been written, and to the former for revising the manuscript. My thanks are due to everyone concerned, which certainly includes the crews, whose courtesy and helpfulness are chronicled in my archives.

Scientific Instruments and Apparatus

No. VII

(*Continued from page 422, May 3rd*)

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LTD.

MUCH research and development work is undertaken at the Trafford Park works of the Metropolitan-Vickers Electrical Company with the object of producing new or improved electrical instruments and apparatus. During the past year attention was paid to the design of miniature thermal instruments for measuring high-frequency currents in radio equipment. These instruments comprise a sensitive moving coil operated by a thermo-couple heated by the A.C. to be measured. The thermo-couples are composed of precious metals of different alloys, varying in diameter from one-thousandth of an inch upwards, according to the current capacity. The wires are electrically welded together to form a junction and the ends are soldered to terminal supports. Two forms have been developed, one using multiple thermo-couples for small currents and a heater type for larger currents.

A new design of edgewise temperature indicator has been developed for furnace work to give increased sensitivity and improved performance. An enlarged magnet system is made from the new "Alnico" magnet steel and has soft iron pole pieces. With a lighter and more efficient moving element, the sensitivity of the instrument has been increased from 12 to 20 ohms per millivolt without sacrificing torque or efficiency.

Development work has recently been carried out on indicators for measuring the temperature of the rotor and stator of an alternator. The rotor indicator consists of a double-element moving coil system working on the ohmmeter principle. One element is operated by a shunt in the main field and the other by the voltage of this supply. The movement is fitted into a case similar to that of the stator indicator and embodies an adjusting rheostat for initial temperature setting and is fused to protect the instrument against a burn out. With a knife-edge pointer indicating on a 10in. mirror scale the movement is of the edgwise type. A single element sensitive millivoltmeter, having a multi-point switch to change over to the thermo-couples situated in the stator windings, constitutes the stator indicator.

To meet the demand for a Buchholz device which will energise its tripping circuit in the event of a falling oil level, an alternative design to the standard float and flap arrangement has been developed. This design embodies the main features of the ordinary arrangement with the exception that the surge flap is replaced by a float. The latter is deflected in the usual manner by an oil surge, but by virtue of being a float it also responds to the condition of falling oil level.

It has usually been the practice where static condensers are employed for power factor improvement to switch the condensers in and out of circuit manually according to the load, but since the omission of switching on only one occasion may cause the maximum demand to be increased, the weakness of manual control is apparent, particularly where the charges for a quarterly, half-yearly, or in some cases yearly periods are determined by the reading of the maximum indicator. But recent designs of a Metrovick relay have made possible the automatic switching in or out of condensers according to the amount of lagging or leading kVA measured at the various centres of a shop distribution system. The condensers are situated in the most effective positions and are switched on to the line by contactors with their coil circuits brought to a control panel. One or more relays control the contactor coil circuits according to the lay-out.

The relay comprises a reactive VA element which by means of contacts controls a motor element having the requisite number of mercury switch contacts according to the number of condensers on a section. The reactive element is a wattmeter type movement connected to measure the VA single-phase and thus has zero torque at unity power factor. Adjustable fixed contacts situated on either side of the zero position are set according to the requirements of a particular installation. By virtue of the relay construction, it has been possible to design each element according to its function, the reactive VA element giving adjustment between 4 per cent. and 80 per cent. reactive VA, while the motor element can accommodate as many as ten mercury type switch contacts, each capable of dealing with contactor coils taking up to 20 amperes at 230 volts.

A Metrovick surgeproof inter-tripping relay for use on the C.E.B. system has been approved by Messrs. Merz and McLellan. The relay is used for initiating tripping at either end of a transmission

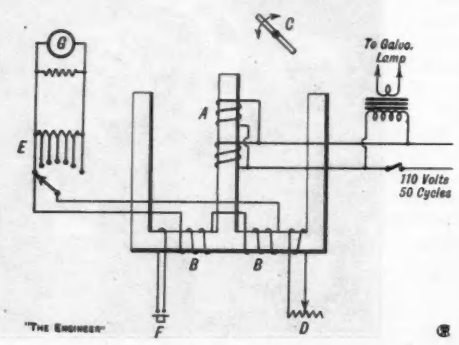

FIG. 67—DIAGRAM OF COIL TESTER

line section upon receipt of a tripping impulse from the other end. Communication between the two stations is obtained by telephone type pilot wires. The relay comprises one of the standard type D.B.A. moving coil devices together with a compensator to minimise interference from A.C. The compensator consists of a choke and "Metrosil" units together with any series resistance that may be required, and the connections are arranged so that while the relay coil circuit offers a low impedance to D.C. a much higher impedance is offered to A.C. and this renders the shunting of the "Metrosil" discs particularly effective under this condition. On a 110 volt D.C. circuit the standard relay operates with a current of 40 mA.

The company is manufacturing an automatic frequency and load control equipment for the Bristol Corporation with the approval and collaboration of the Central Electricity Board. In accordance with the system's frequency and a programme prepared by the Control Engineer, this equipment is to control the load on the generators at the Portishead power station. The generator to be regulated is automatically selected by load-measuring relays and the regulation is accomplished by impulses to the servo-motor on the turbine governor. The impulses are obtained by comparison of time intervals measured by a pendulum clock with similar intervals integrated by synchronous motors, and are therefore accurately proportioned to the frequency error.

The contribution made by the station towards improvement of the frequency is readily adjustable over a wide range by adjustment of the relationship between station load and "frequency time error," a value which is indicated on the equipment. For use in conjunction with the Bristol equipment a super-sensitive watt relay has been designed. The watt element operating in conjunction with the polarised relay prevents chattering contact troubles and permits the use of a very sensitive setting.

But, to return to more detailed description of electrical apparatus, reference may be made to a Metrovick tester for the routine detection of short-circuited turns in coils after winding described by Mr. F. Brailsford in a recent issue of *The Metropolitan Vickers Gazette*. By slipping the coil over a magnetised core an E.M.F. is induced in the coil and a short circuited turn or turns results in a circulating current which disturbs a flux balance in the tester and produces a deflection of an indicating galvanometer. The sensitivity of the apparatus is sufficient to detect a short circuit in a single turn of copper wire down to 0·0028in. in diameter.

It is clear that electrical contact between adjacent turns of successive layers, owing to faulty insulation of the wire, or to defective workmanship, will lead to a failure or imperfect operation of the electrical equipment into which the coil is subsequently incorporated, and the improved tester which the Metropolitan-Vickers Electrical Company has introduced offers considerable advantages. From the diagram, Fig. 67, the principle of operation will be clear.

A magnetising coil A excited with 50 cycle A.C. is wound on the central leg of a three-limbed laminated silicon iron core and the flux produced in this central member divides between the two outer limbs. These two components of flux thread the coils B, connected in series opposition to the vibration galvanometer G. Apart from small departures from exact symmetry in the core and small differences in iron losses in the two outer magnetic circuits, the E.M.F.'s in the search coils B will be equal in magnitude and opposite in phase so that the E.M.F. applied to the galvanometer G will be nearly zero. But to ensure that this E.M.F. is exactly zero an exact balance is obtained by the adjustments shown at C and D. Adjustment of the position of the short strip of iron C by rotating it in the plane of the paper enables the E.M.F. induced in the coil B, normally carrying a slightly lower flux, to be made equal to that of the other coil, while adjustment of the loading on one or other of the outer legs by means of the variable resistance D connected to a winding of a few turns enables exact phase opposition of the two E.M.F.'s to be attained.

If the coil to be tested is slipped over the free outer leg, then an E.M.F. is induced in the coil by the flux in the leg and, if there is an internal short circuit in the coil, a circulating current will flow in the short circuited turns. The reaction of the ampere turns so produced on the magnetic circuit will disturb the previous flux balance and produce a deflection of the galvanometer. If, on the other hand, there is no internal fault and if the self-capacity of the coil is low no current circulates and the galvanometer is not deflected.

For coils of fine wire, smaller than, say, 0·008in. in diameter and with more than about 10,000 turns comparatively high-capacity currents will be experienced even at 50 cycles per second. Mainly these currents flow between layers and across the intervening dielectric, whilst the return path is through the turns. The ampere turns thus set up produce an increase in flux in the leg in phase with the main flux and thus also disturb the flux balance and give a deflection of the galvanometer.

The relative effect of capacity ampere turns and the ampere turns due to a short circuit on 1, 10, or 100 turns, respectively, has been calculated and for one particular coil is represented in Fig. 68. It will be seen that the unbalancing effect of capacity currents is about equal to that due to a short on one turn when the wire diameter is 0·008in., 15 times greater when the wire is 0·005in. diameter, and more than 100 times greater for 0·003 diameter wire. To detect a short circuit in coils where the wire is under about 0·008in. in diameter, it is thus necessary to be able to distinguish between capacity and short circuit ampere turns. These ampere turns components are mutually in quadrature, the flux component produced by the former being in phase with the main flux inside the test coil. The adjustments C and D similarly produce additional flux components in quadrature in the balancing leg, the increment of flux produced by the control C being in phase with the main flux. To determine whether a coil of high capacity contains short circuited turns, the procedure is simply to balance the core in the absence of the test coil and then to see whether the balance can be restored with the coil in position by the adjust-

ment of control C only. If it can, the coil is free from short circuits, whilst if balance cannot be restored in this way the coil contains short-circuited turns.

The laminated core of the apparatus is composed of 0·014in. transformer punchings built up without the use of rivets or clamps, adequate mechanical strength and solidity being obtained by coating the laminations with baking coil varnish and subsequently baking under pressure. The iron section is determined by the smallest internal dimensions of the coils to be tested and the flux density limited so that the test coil induced voltage does not exceed 3 volts per 1000 turns. To

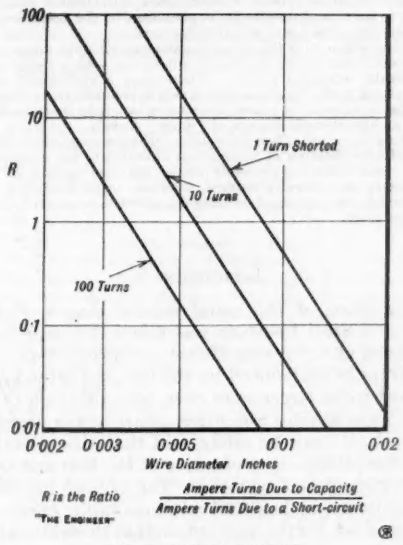

FIG. 68—RATIO CURVES

minimise non-uniformity of flux density along the length of the outer legs the central leg is made rather longer than the other legs and magnetised with two separate coils above one another and connected in parallel to the supply.

A variable galvanometer shunt E, controlled by a spring-loaded fly-back switch, gives the necessary variable sensitivity and protection against accidental damage to the galvanometer. Shunt resistances and other parts of the galvanometer circuits are made non-inductive to eliminate pick-up troubles from extraneous fields and the large stray field of the coil itself. The vibration galvanometer is mounted on rubber sponges and is

FIG. 69—COIL TESTER—METROVICK

enclosed in a stout wooden case which houses the complete apparatus. In Fig. 69 is shown the complete tester with the projecting limb of the core over which the test coils are slipped. The main supply switch and other controls are conveniently placed for the use of the operator.

A zero deflection of the galvanometer indicates a sound coil, but the possibility of a defect developing in the apparatus, causing it to pass unsound coils, has not been overlooked and a simple checking device has been incorporated. When the push button F in Fig. 67 is pressed it short circuits a single turn on the outer leg and thus produces a deflection of the galvanometer. This button is occasionally operated to test whether the apparatus is operating correctly.

With the galvanometer switch in the position of maximum sensitivity a balance is first obtained with no coil on the core by adjusting the controls C and D, Fig. 67. The coil is then slipped over the leg, and if the balance remains undisturbed the coil is free from short circuits. If there is a deflection it may be attributable to self-capacity,

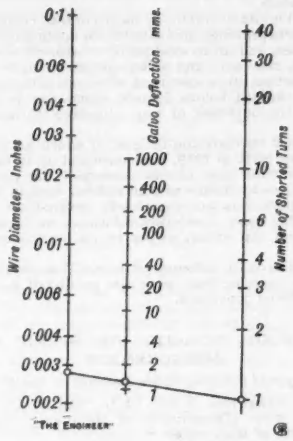

FIG. 70—SENSITIVITY DIAGRAM

in which case the balance can be restored by moving the upper adjustment C. If this fails to restore the balance the coil contains short circuited turns.

The equipment has been designed to cover the following range of coils:—Size of wire, 0·0028in. to 0·104in. diameter; coil length up to 5½in.; radial depth over former up to 2⅝in.; inside dimensions down to $\frac{15}{16}$in. square or 1⅛in. diameter. Coils of twice the length stated can, however, be tested if one half be dealt with at a time. The approximate sensitivity of the tester to a short circuit on one or more turns of copper wire having a mean length of about 6in. may be read off the monograph, Fig. 70, for any diameter of wire. When the size of wire is over the limit specified the sensitivity of the apparatus is such that a small deflection in the neighbourhood of a few millimetres may be caused by eddy currents set up in the copper by stray fields. But it is clear from Fig. 70 that in this case the deflection caused by a short circuit on a single turn is very large and out of all proportion to this small residual deflection. If these facts are appreciated it is evident that the tester may be used, when required, for sizes of wire above the limit given.

The apparatus has been thoroughly tested with coils of various sizes and numbers of turns and with capacity and short circuits artificially introduced. For coils with wire over 0·008in. or 0·01in. in diameter, or of less than about 10,000 turns, the capacity effect is generally negligible. There is no need to balance out capacity ampere turns and tests on a series of coils can be carried out very rapidly. But testing will be slowed down when a defective coil is found, as it is then necessary to ensure that the galvanometer deflection is attributable to a short circuit and not to the coil self-capacity. With coils of high self-capacity the additional operation of balancing out the capacity ampere turns is required for each coil.

The particular apparatus described has been designed for testing a particular range of coil and wire sizes, but similar equipments to deal with, for example, larger coils of larger copper section could, of course, be built on the same principle.

(To be continued)

Iron and Steel Institute

THE spring meeting of the Iron and Steel Institute was held on Thursday and Friday, May 2nd and 3rd, in London. Owing to the great pressure upon our space caused by the paper shortage we are unable this year to give as much attention to the meeting as usual, and cannot report the discussions or reprint a selection of the papers. We give, however, the official summaries of the papers and the presidential address of Mr. John Craig, which was delivered on Thursday, after the usual routine proceedings.

Presidential Address

Mr. Craig opened his address with a review of the changes which have taken place during the period of his association with the iron and steel industry. Concluding this section, he said:—"Still, even recognising the advances which have taken place during this time, we are forced to think that this can only be the beginning, for fifty years in the history of an industry is a short period. Who can say but that in the future the dream of eliminating the blast-furnace, while it may never come true in its entirety, may lead to some combination with the melting furnace that will substantially reduce the cost of transforming the iron ore into the steel ingot; and even the cogging mill may have to give place to some invention that will eliminate the ingot and transform the molten steel direct to an advanced form ready for the market.

"We have witnessed the evolution from the coal-fired open-topped blast-furnace, with all its prodigal and wasteful use of fuel, to the modern blast-furnace, producing in a day twice as much iron as was produced in a week, and the development of the melting furnace producing instead of 100 tons per week probably twenty-five times that quantity. At the same time, raw fuel has been practically eliminated from the steelworks, for we now see coke-oven and blast-furnace gas being used to melt the steel and then to heat the ingot, the slab and the annealing furnace, and to raise steam to produce sufficient electricity for all the plant required to finish the steel ready for the market. I believe, too, that we are within sight of the abolition of raw coal even for the steam locomotive, as there appears to be no reason why it should not be fired with compressed coke-oven gas, and thus brings us to the coal-less steelworks.

"All this has happened in the past fifty years, and when someone fifty years hence addresses the Institute on somewhat similar lines to what I have done to-day, he will probably be able to record achievements which will be even greater than those to which I have referred."

He then touched upon price-cutting and price-control, summing up his views in these words:—"I think, therefore, that it will be admitted that the method recently adopted of regulating prices on a basis of cost is a sound one and should have the effect of forcing the industry at all times to consider its costs of production and then to regulate the selling price accordingly. To those who are fond of speculating, it may have robbed the industry of some of its charm, but I think it will make for a sounder basis in the future. It is a policy which will have its influence, I am sure, upon the efficiency of the industry, for it will help to prevent successful commercialism from hindering progress in the means of production."

The address concluded with the following passages:—"While admitting that some of the pioneers in the industry showed great courage and possessed also sufficient optimism to carry them through many difficulties, they were not altogether free from pessimistic criticism. I remember Sir Hugh Bell telling me that his distinguished father, Sir Lowthian, had expressed the opinion that it was folly to increase the output of pig iron in Britain when it had already reached 4,000,000 tons per year. Sir Lowthian held the view that there never could be a market for an increased output. I can well recall how, when one of my predecessors was anxious to build some additional open-hearth furnaces in the early 'nineties, a good friend of the company appealed to his senior to stop what he described as the folly of the young man in desiring to make more steel, because the country could never consume it. It is always a difficult problem to know how to handle the periodic waves of pessimism which seem to creep over the world from time to time. Yet I think it can be safely assumed that the best time to build new furnaces is when the prophets declare that the country has too great a productive capacity. It would seem that those who have acted on this policy in the past have nothing to regret.

"It would be difficult indeed to say when a country has sufficient steel for all its requirements. The general advance in civilisation seems to move with an increased output of steel. Whether it is steel that makes civilisation or civilisation that

makes the demand for steel is a problem that I leave with you, but the fact remains that the two have grown together, and it does appear as if each step forward in civilisation demands more steel, and that with the production of increased quantities and improved qualities of steel, an increase takes place in the standard of living, and so civilisation marches on. The luxuries of life are associated with steel, and while it may be that there are critics to-day who regret the development of the tin-opener and look upon it as a sign of decadence in domestic life, there can be no denying the fact that the tin can is providing the public with luxuries which, without it, would be quite impossible. It is spreading abroad the natural products of the world without limits as to temperature. As a means of storing foodstuffs, it is providing a safeguard against any local disaster that would inflict a shortage on a community. It gives to us the realisation of the benefits of laying up the surplus from the plentiful harvest for the inevitable shortage that comes.

"I would like to think that I have made my younger friends in the Institute feel that they are associated with a great industry which has still within it vast stretches of undiscovered possibilities. To them is the satisfaction of knowing that in their hands lies an opportunity which provides unlimited scope for all the knowledge they can acquire and for abundant research.

"I feel confident that what has been done during the past fifty years is no more than a foundation upon which the present and future generations can build a nobler structure."

We give below the authors' summaries of their papers in the order in which they were presented.

RESEARCHES INTO THE STRUCTURE OF ALLOYS

By A. J. BRADLEY, F.R.S. (Assistant Director of Research, Cavendish Laboratory, Cambridge), W. L. BRAGG, F.R.S. (Cavendish Professor of Experimental Physics, Cambridge), and C. SYKES, D.Sc. (Research Department, Metropolitan-Vickers Electrical Company, Ltd., Manchester).

The paper describes a body of related researches which have been carried out in the last few years.

Part I deals with the investigation of equilibrium diagrams by means of X-ray analysis, in particular the analysis of binary and ternary diagrams with the component metals chromium, iron, cobalt, nickel, copper, and aluminium. Structures of submicroscopic order of magnitude and the theory of the order-disorder transformation are also reviewed.

Part II deals with the experimental investigation of the order-disorder transformation, using the alloys of β-brass, Cu_3Au, Cu_3Pd, and Ni_3Fe. The values found for the energy of the transformation are in satisfactory agreement with those predicted by the theoretical treatments given by Bragg and Williams, Bethe, and Peierls. The thermal methods specially developed for the above investigation have also been employed to determine the specific-heat/temperature curves of iron, nickel, and a number of age-hardening alloys. The results obtained from consideration of these curves are recorded.

THE MANUFACTURE OF PIG IRON IN AMERICA

By WILLIAM A. HAVEN (Cleveland, Ohio, U.S.A.).

In this paper on the manufacture of pig iron in America, the author's specific purpose is to describe the designs, equipment, and practices which characterise practically all modern American blast-furnaces, notwithstanding some great differences in the nature of the raw materials used in the principal producing districts.

The chief pig-iron-making districts are first reviewed briefly (Mexico, Nova Scotia, Southern or Alabama District, Rocky Mountain District, Eastern New York, and Pennsylvania District, Mid-Western District), and then data on the iron ores of the Lake Superior District are presented (chemical qualities, iron content, beneficiation, reducibility, physical characteristics, output). Next, a description of the transportation of lake ores (distances and charges, storage facilities, lake carriers) is followed by an account of Appalachian coking coals and coke (river transportation, transport costs, mining methods, quality of coal, coke-ovens, and the blast-furnace plant, coke quality). Attention is then directed to blast-furnace plant and equipment, and detailed consideration is given to raw-material unloading facilities, raw-materials storage, stock-house bins, bottom and top charging equipment, the stack, the cooling, the lining and dimensions of blast-furnaces, casting facilities, metal and slag handling, power plants and blowers, hot-blast stoves, gas-cleaning equipment, and sintering and sintering plant. Finally there is a short section on blast-furnace practice in America.

Numerous illustrations and tables of data are included.

REPORT ON CORROSION RESEARCH WORK AT CAMBRIDGE UNIVERSITY INTERRUPTED BY THE OUTBREAK OF WAR

(Paper of the Corrosion Committee)

By U. R. EVANS, Sc.D. (Cambridge University).

A description is given of researches by a group of investigators interrupted by the war; the results obtained up to September, 1939, are summarised, and interpretations—necessarily tentative—are suggested.

Agar's exploration of the potential distribution close to the surface of zinc partly immersed in chloride or sulphate solution showed definitely that electric currents were passing between a cathodic zone, situated in the well-ærated region at the meniscus, and an anodic zone below it. Visible corrosion was always associated with the zone which the electrical apparatus showed to be anodic. From the distance between equipotential lines, the strength of the currents could be calculated. It was found that these were strong enough to account for at least the *greater part* of the corrosion—and probably for the whole of the corrosion leading to *loose* corrosion product (the small amount of adherent corrosion product has a different origin). The researches had not proceeded far enough to ascertain whether there was an *exact* equivalence between current strength and corrosion rate, but they have established the fact that the attack is at least mainly electrochemical.

A convenient criterion of the protective character of a film is the amount of acid which must be added to copper nitrate to cause deposition of copper when a drop is placed on an iron surface. The author's comparative tests on heat-tinted and other specimens of carbonyl iron have confirmed the belief that iron carrying interlocked oxide is better protected than iron carrying somewhat thicker films, where the interlocking is less. The tracing of a scratch-line with a weighted needle on tinted iron did not, in general, perceptibly increase the susceptibility to attack, provided that there was a short exposure to air before the placing of the drop on the surface. But specimens which have been kept two years in a desiccator after tinting showed a significant increase of susceptibility when freshly scratched.

Mayne's attempts to obtain, by means of water-emulsification, a rust-inhibitive priming paint suitable for application (*a*) to steel wet with water, and (*b*) to steel partly weathered so as to carry broken scale, rust and iron salts, appear to have succeeded, so far as objective (*a*) is concerned, although prolonged outdoor tests will be needed before definite claims can be made. At the time of the outbreak of war, objective (*b*) had not been attained.

Gould's work on corrosion-fatigue, of which an account had been published early in 1939, was continued up to the outbreak of war; the chief new results concerned the prevention of corrosion-fatigue by means of zinc ribbon, even in cases where the steel surface was not completely covered up. This was effective in the case of chloride solutions, but less so in the case of typical tap water, owing to its lower electrical conductivity.

Hoar's results on the influence of the steel base on the corrosion of tin cans containing fruit were also published in 1939; this work is still being continued.

THE DAMPING CAPACITY OF STEEL AND ITS MEASUREMENT

(Paper of the Alloy Steels Research Committee)

By G. P. CONTRACTOR, M.Sc., Ph.D., and F. C. THOMPSON, D.Met., M.Sc. (Department of Metallurgy, the Victoria University of Manchester).

The Föppl-Pertz apparatus for the measurement of "damping capacity" was found to yield unduly high values, mainly as the result of frictional losses between the stylus and the recording medium. To eliminate these, the instrument was modified so as to employ an optical recording device. Particular attention has been paid to a consideration of the effect on damping capacity of factors such as the initial stress, bending, size, and shape of the specimen, &c. An account is given of experiments to study the influence of moderate temperatures on the damping capacity of a series of typical steels.

This work, which is of an exploratory nature, covers only an account of the experimental results and no attempt is made to deal with them theoretically.

THE ESTIMATION OF HYDROGEN IN STEEL AND OTHER METALS

Paper of the Oxygen Sub-Committee of the Heterogeneity of Steel Ingots Committee.)

By W. C. NEWELL, Ph.D., D.I.C., A.R.C.S., B.Sc., A.I.C. (The Brown-Firth Research Laboratories, Sheffield).

An account is given of the development of the vacuum-heating method of estimating hydrogen in metals (especially steel). The theoretical basis of the method is discussed, and a description of an apparatus designed for the study of the hydrogen content of metals is given together with results of tests upon the method itself and upon metal samples. The rate of evolution of hydrogen from steel at various temperatures has been studied, and it is confirmed that the amount of hydrogen given off by this method is the same as that by the vacuum-fusion method.

HEAT TRANSFER IN THE FLOW OF GAS THROUGH A BED OF SOLID PARTICLES

By O. A. SAUNDERS, M.A., and H. FORD, Ph.D. (Imperial College of Science and Technology, London).

The problem of the transfer of heat from a gas to a bed of solid particles is approached from first principles, in order to relate the heat transfer to the shape and dimensions of the bed and particles, the physical characteristics of the material, the velocity and temperature of the gas, &c.

It is shown theoretically that the heat transfer is governed by the dimensionless groups $V\,rc'/lc$ and $V\,lc'/k$, and by the shape of the bed and particles (V=mean linear velocity of the gas entering the bed; r=time; c'=specific heat of unit volume of gas at constant pressure; l=characteristic linear dimension; c=specific heat of unit volume of material of the particles; k=conductivity of the particles); also that $V\,lc'/k$ may be neglected if it is small enough, that is to say, if the size, l, of the particles is small enough, or their conductivity, k, large enough, for the effects of temperature differences in their interiors to be neglected; in such cases the thermal conductivity of the particles is of no importance.

Once the validity of these groups has been checked experimentally, the results can be applied to the whole possible range of materials, provided that their physical constants are known.

Experiments to test out the theory are described, in which hot air was passed through beds of various depths of steel, lead, or glass spheres of diameter up to 0·25in. It was found that the results for different sizes, velocities, and materials could be correlated with $V\,rc'/lc$, indicating that the effects of temperature differences within the particles were negligible in the experiments.

Curves are given for calculating the variation of gas temperature through a given bed at any given moment. It is shown, for example, that the time taken to attain a given temperature at a given depth of bed is directly proportional to the specific heat and density of the particles, inversely proportional to the gas velocity, and only slightly affected by changes of particle size. Curves are also given for the heat transfer.

The highest value of $V\,lc'/k$ in the experiments was about 4, corresponding to diameters of 0·25in. and 1·1in. for glass and steel, respectively, at an air speed of 2ft. per second. The results are, therefore, applicable up to these sizes; how far they are valid for larger sizes remains to be found by further experiments, but rough calculations show that the errors in using them up to sizes two or three times those quoted are probably only a few per cent.

Although only part of the ground has been covered in the present experiments, it is hoped that the methods developed will in due course be extended to cover the whole field, and eventually include the more complicated conditions found in industrial plant.

METHOD OF SCLERO-GRATING EMPLOYED FOR THE STUDY OF GRAIN BOUNDARIES AND OF NITRIDED CASES; GRAIN STRUCTURES REVEALED BY CUTTING

(Report on a research carried out with the aid of a grant from the Andrew Carnegie Research Fund, received July 20th, 1939.)

By Bo O. W. L. LJUNGGREN (Metallografiska Institutet, Stockholm).

Use has been made of the method of Benedicks and Mets for the detailed study of relative hardness, namely, ruling a fine grating on a polished metal surface. This procedure—designated here as "sclero-grating"—has been made highly sensitive, mainly by making the point-bearing part very light, with great lateral stability. Thus, the hardness difference between adjacent grains clearly reveals the grain structure of a metal—as in grain field etching. By the use of very low pressure and a small ruling distance it is possible to detect cold-working resulting from grinding.

On iron as well as on aluminium, after annealing in nitrogen, grain boundaries were observed for which the sclero-grating method indicated a slightly greater hardness than that of the ground-mass, without any separated phase being visible there under the microscope. This may be interpreted as a molecular enrichment of nitride in the boundaries in support of the theory of Benedicks and Löfquist.

It has been shown that in order to reveal small hardness differences a strictly geometrical shape of the ruling point is by no means necessary; particularly high sensitivity is frequently attained through the action of a "secondary point."

Good harmony has been found to exist between the configuration of the ruling point and the rulings obtained when examined at a high magnification.

The sclero-grating method has also been employed for the detailed study of the individual hardness of the micro-constituents of a nitrided case. Consideration of the results obtained seems to provide a reasonable explanation of the behaviour of the total-hardness curve of a nitrided steel.

In connection with the sclero-grating experiments, some tests have been made on the cutting of soft metals with a sharp knife (a laterally extended point). When using a sufficiently large free-cutting angle the grain structure was beautifully developed, and also a remarkable coarse structure which may be considered to be a characteristic feature of "pure" metals.

During the work, a few other observations were made. Thus, on prolonged heating of commercial aluminium, the compound Al_3Fe was found to protrude above the free surface of the specimen; in a nitrided surface, a certain crack formation was observed and is explained as being due to blisters caused by local high pressure.

LUNCHEON

The place of the usual annual dinner of the Iron and Steel Institute was taken this year by a luncheon at Grosvenor House on Friday, May 3rd. Far from being reduced by the war, the attendance seemed to be larger than ever, and although there were some notable absentees owing to the pressure of work, it may be safely said that the assembly was completely representative of the iron and steel industries of this country. The annual luncheon of Institutions has had a remarkable effect on the toast list, for the assumption that those attending are itching to get back to work instead of to bed has caused a marked reduction in the number of speeches. On Friday last there were only three. Sir William Bragg, President of the Royal Society, led off by proposing the toast of the Institute in a delightful and characteristic little address on the value of science in industry, with particular application to iron and steel. In his acknowledgment of the toast, the President included a reference to the guests of the Institute and of its members, and Rear-Admiral B. A. Fraser, Third Sea Lord and Controller of the Royal Navy, replied in a cheering speech. He spoke particularly of the part that the Fleet Air Arm had played in the Norwegian campaign, and of the little anti-aircraft ships which fought with the enemy till their last cartridge was expended. The Admiral mentioned that in some cases the pilots of the Fleet Air Arm rather than lose contact with the enemy had fought till the last ounce of their petrol had been consumed and they were forced down on the water. In most cases the Navy had been able to recover the crews, whose first question always was "Where is my next ship?" Speaking of the loss of the "Bittern" he said that she had been in action all day and had used up practically all her ammunition, when the last bomb of perhaps one hundred and fifty which had been dropped around her found its target.

A WOODEN FLOATING DOCK.—A wooden floating dock 450ft. long and 75ft. wide is reported to be under construction in Siberia at the town of Tobolsk. With a lifting capacity of 1200 metric tons, it is said to be the largest of its kind yet constructed, and is to be used in the repair of local river craft.

PROTECTIVE OXIDE FILM FOR TINPLATE.—At the laboratories of the International Tin Research and Development Council a new process has been developed for the production of a protective oxide film on tinplate which, although invisible, gives good protection from the sulphur staining imparted by certain canned foods. In experiments carried out to produce this film, the method first used was to immerse the tinplate in a hot solution of chromic acid for fifteen minutes. This process, however, had several disadvantages, the chief being that the film of palm oil left on the tinplate from the hot-tinning operation had first to be completely removed—an operation which was found to be rather difficult. Experiments were therefore carried out with alkaline agents, so as to obtain a solution which would simultaneously remove the oil film and produce an oxide film. Eventually, a hot alkaline solution containing sodium phosphate and a chromate was devised which served the purpose. Further work has resulted in the time required for the treatment being reduced from 15 minutes to 2 minutes, with the possibility of a still further reduction. The film as now developed, although so thin as to be invisible, has been found to give good protection from sulphur staining, and to prevent bleaching of the contents with many canned vegetables. It has also been found effective with meat products and soups, and preliminary tests with fish products are promising. Tests with fruits, however, have given poor results, as the film appears to be slowly dissolved by the citric acid present.

Rail and Road

NEW VEHICLE REGISTRATIONS.—A return of the Society of Motor Manufacturers and Traders, Ltd., of the mechanically propelled road vehicles registered for the first time in this country under the Roads Act, 1920, shows that 14,590 vehicles were registered in March last, as compared with 56,821 in March, 1939.

A DERAILMENT ON THE L.M.S.—When nine coaches of a Liverpool to London express train were derailed on the London, Midland, and Scottish Railway at Atherstone on April 25th the track was torn up for some considerable distance. The coaches remained upright and although the track was badly damaged no passengers were hurt.

CLAIM FOR INCREASED WAGES ON THE RAILWAYS.—The Railway Executive Committee did not reach a conclusion when it recently discussed the claim of the three railway trade unions for a further increase in wages of 6s. a week for 500,000 workers. Having heard the Union's case it has promised to consider the matter and to give a reply as soon as possible.

NEW TRAFFIC SIGNAL INSTALLATION IN LONDON.—After many months of study the authorities have devised a suitable scheme of automatic traffic signals for the Bank. Traffic control at this point is particularly complicated and normally requires the attention of nine policemen. The new scheme which will be the biggest yet attempted in this country will, it is expected, be completed in the early summer.

A LONDON STATION CLOSED.—Haggerston station, between Dalston Junction and Shoreditch on the London, Midland, and Scottish Railway Company's North London section, was closed on Monday, May 6th. For passenger traffic, both Dalston Junction and Shoreditch stations are in close proximity, whilst there are also frequent alternative L.P.T.B. road services. Dalston Junction will deal with parcels for Haggerston and with traffic brought to the station for despatch.

EXPORT OF BICYCLES AND MOTOR-CYCLES.—At the request of the Export Council export groups are to be formed for the bicycle and motor-cycle industries. Mr. H. R. Watling, director of the British Cycle and Motor-Cycle Manufacturers' Union, has accepted the chairmanship of both groups. Before the war, the United Kingdom exported each year some £1,500,000 worth of bicycles, £800,000 worth of motor-cycles, and parts and accessories for both to a value of £2,000,000.

WATERLOO BRIDGE.—The question of the completion of the new Waterloo Bridge under war conditions has been considered by the London County Council, and arrangements have been made for the work on the Portland stone facing of the spans to proceed in accordance with the contract; for the south-western and north-western stairways to be completed; and for work on the north-eastern and south-eastern stairways to cease at about embankment level for the present.

AN AMERICAN RAILWAY MOTOR-CAR SERVICE.—An interesting innovation on a number of railways in the United States is a train-motor-car travel service by which a traveller can travel long distances by train and have a motor-car at his service at the end of his journey. The motor-cars can be booked when purchasing the ticket at the beginning of the journey or alternatively be hired at the station on arrival. About 150 cities served by the railways concerned have been supplied with motor-cars of popular makes under the new scheme.

THE "CORONATION SCOT."—As a result of representations made to Lord Stamp by the authorities of the New York World's Fair and the leading American railway companies, it has been decided to exhibit again the "Coronation Scot" at the World's Fair which re-opens on May 11th. Owing to ocean transport difficulties when the fair closed last year it was decided by the London, Midland, and Scottish Railway Company to store the train for the duration of the war at Baltimore. It is not considered that circumstances justify the exhibition of the complete train and the locomotive only is being re-assembled.

COMMERCIAL VEHICLE HEADLIGHTS.—In a statement on road transport and the black-out conditions in its monthly bulletin of road information, the British Road Federation says that the present single feeble headlight legally permitted for commercial motor vehicles is a grave impediment to industry. It urges that the Ministries concerned should endeavour to devise some relaxation in order to provide better lighting conditions. It is considered that if preparations were made in advance vehicles on many of the main routes could be allowed a better degree of illumination, provided that the A.R.P. and other services concerned were so organised as to give a period of warning for lights to be turned off if occasion demanded. A suggestion is also put forward that all kerbs should be whitened, the use of intermittent white lines denoting traffic lanes on straight stretches of road extended, and also a uniform system of visible police signals adopted throughtout the country.

LOADING LONG RAILS.—An extract from an American journal in the *Railway Gazette* describes an interesting method of loading a number of 1400ft. long lengths of 131 lb. rail from a ground level stack. The method was devised by engineers of the Delaware and Hudson Railroad. The ends of the rails were first raised on to a ramp terminating in a trestle, spanning a specially laid track, so as just to clear the trucks. The part of the track beyond the trestle was laid in a straight line along the centre line of the rail stack produced. The section of track under the raised ends of the rails curved outwards, however, clear of the rail ramp, and then, with a reverse curve, was laid parallel to and for the length of the rail stack. A train of flat trucks was backed on to this track until the car next the engine was under the trestle. Two of the rails were attached to the engine, which, in moving slowly forwards, pulled the two rails and the trucks, so that the rails came up the ramp and over the trestle, and the trucks came over the reverse curves beneath the rails ready to receive them. The loading of two 1400ft. rails was thus effected on the train of flat trucks, which was then pushed back to its original position, and the process was repeated till the train was loaded.

Miscellanea

OIL FIND IN FRANCE.—It is reported that oil has been discovered in the region of Saint Guadins in the Pyrenees and the first bore opened produced about 5000 gallons in the first few hours.

SOFT SOLDERING MONEL METAL AND NICKEL.—A note in *Monel Notes* points out that monel and nickel are readily soft soldered, although of course the strength and ductility of such solders is not sufficiently high to make such joints advisable where any considerable vibration is likely to be involved. It is recommended that, in making a lock seamed joint, the edges of the sheets should be tinned or coated with a thin film of soft solder before forming the sheet and before lock-seaming. Once the sheet has been properly tinned, it is then very easy to flow in the soft solder and make a tight joint which is reasonably strong. Similarly, in sweating a tube into a header, if both the header and end of tube are tinned first, then assembled, heated, and solder flowed in, a sound joint will be obtained. It is necessary, as in all soldering work, to have surfaces clean and bright if joints are to hold.

STANDARD SIZES FOR PAPERS.—From time to time efforts are made to bring all technical periodicals within a small selection of standard sizes, not infrequently on the grounds that display advertisers would then be able to standardise their advertisements. There is not a little misunderstanding on this point, and we commend to the attention of the Publicity Departments of engineering firms a brochure just issued by the Incorporated Society of British Advertisers, Aldwych House, London, W.C.2. By an ingenious tabulation it shows how blocks may be used on pages of various sizes. From the editorial aspect the large size of THE ENGINEER has advantages which we should sacrifice with regret, and we welcome therefore anything which may help to convince the advertiser that lack of standardisation of format is not an insurmountable objection to the effective use of the same blocks in several periodicals.

ABSORPTIVE FORMS FOR CONCRETE.—A number of tests has been carried out by the United States Bureau of Reclamation in order to discover a type of form lining for concrete which absorbs air bubbles and excess water, and thus produces a close-textured surface capable of resisting abrasion and cavitation. It was found that the concrete adhered to fabricated absorptive boards, whilst if they were coated with linseed oil the setting of the concrete was delayed and the degree of absorption reduced. A smooth surface free from voids was produced by covering the boards with muslin. Comparative alternate freezing and thawing tests on concrete specimens cast in muslin-covered absorptive forms, and in ordinary wood forms showed that the former sustained no loss of weight after 50 exposure cycles, but the latter a 22·5 per cent. loss. The liability to crazing was markedly reduced by the use of covered absorptive forms.

PORTABLE EMERGENCY WINDING GEAR FOR MINES.—The Sheffield correspondent of *The Times Trade and Engineering Supplement* gives particulars of a portable emergency winding gear for mines for the rescue of men in a pit if the pithead gears are put out of action, which has been provided through the West Yorkshire Coal Owners' Association to the Mines Rescue Station at Wakefield. It comprises an 18 ton road engine 22ft. long, 8ft. wide, and 11ft. high, with a locomotive type boiler, underneath which is slung the winding gear. The complete equipment with about 850 yards of ¾in. diameter wire rope, of the flattened strand non-twisting type, weighs 18 tons. It is intended to operate within a radius of 21 miles of Wakefield, and is capable of hauling six men at a time at a speed of 8ft. a second. The maximum safe weight which can be hauled is 4¼ tons, and as the normal weight of six men with the hoppet and pulley would be about 2 tons there is a large margin of safety.

HEATING BY AIR DRAWN FROM THE EARTH.—It is now a well known fact that considerable quantities of air can be drawn out of the earth without having to overcome a very great resistance, and according to the *Sulzer Technical Review* a number of ventilating plants have been installed for utilising the warmer air obtained in this manner. It is pointed out that at the Swiss National Exhibition at Zurich a plant of this kind was exhibited. It was fitted with a Sulzer fan and used for ventilating rooms in a farmhouse. Of late years plants have been installed in which the air drawn from the earth is used for heating, for example, in garages, where heating in the usually accepted sense of the word is not necessary, but where the temperature of the air must nevertheless be kept from becoming too low. These installations consist of a simple fan set which draws the air from a moderate depth underground and discharges it into the rooms to be warmed. The possibility of heating is due to the fact that the temperature of air drawn from the earth in winter is seldom less than 50 deg. to 60 deg. Fah.

HEAT MEASUREMENT IN LARGE BUILDINGS.—A novel device is described in the *Sulzer Technical Review* whereby the cost of heat from a central heating system may be charged to each tenant in a large block of buildings in accordance with the amount used. It comprises a small apparatus fitted with a small glass tube bolted to each radiator. The glass tube contains a liquid that evaporates in accordance with the use of the heating element. The quantity of liquid evaporated, which can be read on a scale, gives a basis for measuring the heat consumption. The quantities of heat required from all the radiators in a building have only to be added together at the end of the heating season and divided by the total consumption of the whole house in order to determine what share of the cost of heating has to be borne by the tenant of the apartment in question. The small glass tubes are sealed, and are accessible only to an inspector. Since it is natural to assume that each tenant will endeavour to have his apartment charged with the smallest possible share of the total heating costs, a considerable quantity of fuel will probably be saved for the whole building; it has been found that such savings may amount to 33 per cent. and more of the former heating costs. Sulzer Brothers have acquired the manufacturing rights of this invention.

Air and Water

SAILING OF THE "ILE DE FRANCE."—The French liner "Ile de France" which has been in New York Harbour since the outbreak of war left the harbour on May 1st.

NEW AUCKLAND–SYDNEY AIR SERVICE.—On Tuesday, April 30th, a regular weekly flying-boat mail and passenger service between Auckland and Sydney was inaugurated by Tasman Empire Airways. This is the final link in the air service between this country, Australia, and New Zealand.

LIGHTING OF SHIPYARDS IN THE BLACK-OUT.—A deputation of the Confederation of Engineering and Shipbuilding Unions recently met Home Office officials to discuss a scheme for the improvement of lighting in shipyards during the black-out. As a result experiments are to be made at two shipyards and a scheme is to be devised for general application to shipyards during the winter months.

TWO BRITISH SUBMARINES LOST.—The Admiralty announces that the two British submarines "Tarpon" and "Sterlet" are now considerably overdue and must be considered lost. The "Tarpon" was of the "Triton" class and had a displacement of 1095 tons and was armed with one 4in. gun and ten 21in. torpedo tubes. The "Sterlet" was of the "Shark" class, and had a displacement of 670 tons, her armament including one 3in. gun and six 31in. torpedo tubes. Since the outbreak of hostilities this country has lost seven submarines.

NEW ITALIAN BATTLESHIP COMMISSIONED.—It has been announced by the Italian authorities that the new battleship "Vittorio Veneto" has been put into active service. This is the first of the four new vessels of the "Littorio" class which are under construction. According to *Jane's Fighting Ships*, these ships have a standard displacement of 35,000 tons, their main dimensions being length, 775ft., beam 106½ft. and mean draught 20ft. Their propelling machinery has a total shaft horsepower of 130,000, giving a speed of 30 knots. They carry nine 15in., twelve 6in., and twelve 3·5in. A.A. guns, together with a number of smaller guns and three aircraft.

TRAINING MEN FOR SHIPYARDS.—Reports state that steps are now being taken on the North-East Coast by which a certain amount of training will be given to some of the unskilled unemployed men to make them more suitable for jobs in shipyards and factories. Shipbuilders and marine engineering companies on the Wear are co-operating with the educational authorities in this work, and it is intended to take over some old engineering works and adapt them for training purposes. At Jarrow a similar scheme started by employers and the educational authorities has an elementary beginning which will gradually lead to skilled training.

NAVAL CONSTRUCTION IN AUSTRALIA.—In Australia, at Whyalla, in Spencer's Gulf, work is rapidly progressing in the construction of an extensive industrial area which will include slipways, shipyards, a blast furnace, and harbour works. According to the Adelaide correspondent of *The Times*, these works are being carried out by the Broken Hill Proprietary Company in view of the understanding that the British Government will ask Australia to build naval auxiliary vessels. In connection with the works, plans are in hand for the construction of a pipeline 240 miles long to convey water from Morgan on the River Murray to Whyalla. The pipeline will provide Whyalla with 1000 million gallons of water annually and distribute 900 million gallons to districts en route.

PLATING LIGHT ALLOY CYLINDER BORES.—The Journal of the Institution of Automobile Engineers gives particulars of a Swiss patent for the coating of the inside of light alloy cylinders with a thin layer of harder, wear resisting material, which has been acquired by a German concern. In this process the cylinder is fixed on top of a vertical hollow spindle which can be rotated. A journal within this spindle carries a small crucible with an outlet near the bottom, which is directed towards the cylinder wall. The molten metal is filled into the crucible and impinges on the cylinder surface at the top. The cylinder is rotated at high speed, and the crucible is slowly lowered so that the metal covers a narrow thread-like path. Owing to the high speed of rotation the hard metal is forced on to the cylinder wall, the upper layer melts and results in a firm bond free from cracks and of good heat conductivity. It is claimed that centrifugal force gives rise to a smooth surface and that it is possible to produce a thin continuous layer of approximately uniform thickness. Either a light alloy of greater hardness and higher melting point than the cylinder or any harder metal, such as cast iron or steel, can be employed.

ITALY'S AIR FORCE.—Whilst a considerable number of Italy's aircraft are obsolescent, authority has been given to increase strength by one third, and several new types are now going into production. Out-of-date squadrons are being re-equipped as rapidly as possible, but it is doubtful whether the Italian aircraft industry can obtain sufficient raw materials to fulfil requirements. It is, however, well to bear in mind that under the present regime there has been a big improvement in production and training on new types. Peak efficiency should be reached in three years. The Italian Air Force, like the German, is equipped with two or three standard aircraft types in each category. Probably the best-known land bomber is the three-engined Savoia-Marchetti 81 which with the Savoia 79, played a large part in the Spanish war. The other chief bomber type is the B.R.20, powered with two Fiat engines. Among the fighters the Macchi 200 single-engined monoplane is the best in service, followed by the Fiat G–50, a single-engined, single-seat, low-wing monoplane. The C.R. 32 and C.R. 42 are both single-seat fighters, the former being the fighter type chiefly used in the Spanish campaign. For sea and land reconnaissance the types in service are the CANT. Z–501 and the R.O. 37 respectively; the first-named is a single-engined flying-boat resembling the Dornier D.O. 18 in appearance. For bombing operations at sea the service aircraft is the CANT. Z–506, a three-engined float seaplane. Among the service aircraft used in Libya, the Ghibli twin-engined monoplane is still to be found. The well-known Caproni Ca 133 is an obsolescent type which still serves in Abyssinia, but is now being replaced.

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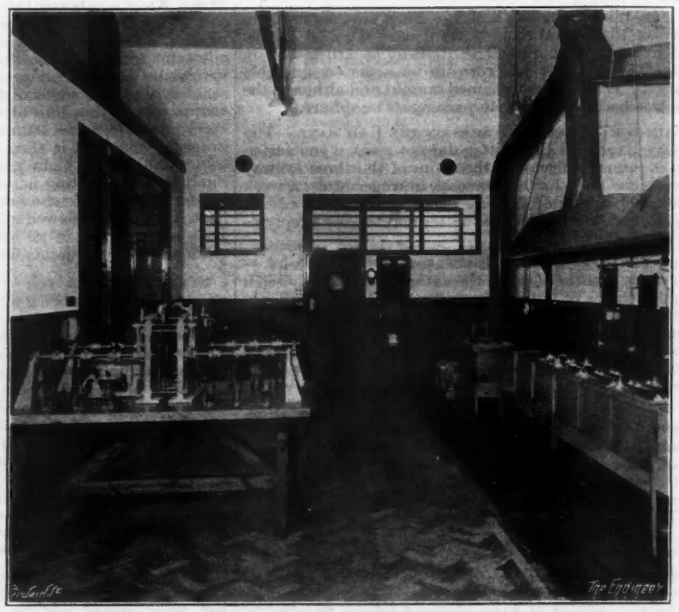
(*For description see page 439*)



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PUBLISHING AND ADVERTISING

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GENERAL

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"Microblitzkrieg"

IN a communication received from one of the largest electrical engineering companies in the United States we learn that among the company's exhibits at this year's New York World Fair will be a "microblitzkreig show." Tiny micro-animals magnified to the size of porpoises will be seen dancing to strange rhythms in a drop of water. Then with a flash of light and a crack of electricity millions of them will be blown to bits by the ultra-violet "death ray" of the firm's sterilising lamp. The rays of this lamp, it is carefully added, while fatal to microbes are harmless to human beings. Accompanying the demonstration there will be "a fantastic full-colour comedy film" which will explain allegorically "how science has learned to protect human life from bacteria." By a happy coincidence we received simultaneously a communication from a British firm specialising in the manufacture of ultra-violet and infra-red equipment. From it we gather that we are not to remain neutral in the "microblitzkrieg." The British company is ready to supply "air-sanitation" equipment designed to eliminate from the air which we breathe the germs which account for eighty-five per cent. of modern illness. Years ago, it reminds us, our fathers died from drinking water infected with sewage germs. The next generation, it prophesies, will look with disgust on the way in which we now breathe air contaminated with germs spread by sneezing and coughing. Irradiation of the air by means of short-wave ultra-violet rays generated by quartz-mercury discharge tubes has, it seems, been proved to be one hundred per cent. effective in killing all germs which come within its range.

In conversation with members of the medical profession we have never found any inclination on the part of that profession to withhold from the engineer full acknowledgement of the vital share which he has played in improving the standard of public health. The doctors admit that they can do no more than endeavour to discover the cause of disease and to find such remedies for it as may serve to cure or alleviate it after it has attacked the human body. Once the cause has been discovered the medical profession in most major instances leaves it to the engineer to take steps designed to counteract it and to prevent the onset of disease. Less than a hundred years ago cholera was widely believed to be caused by the eating of unripe fruit. Medical research found its true origin in infected drinking water. That knowledge was passed on to the engineer and it is he who by providing the works which give us our continuous supplies of pure water has eliminated cholera as one of the major plagues. Malaria was at one time held to be caused, as its name implies, by the breathing of foul air. Investigations by medical workers traced it to infection imparted by mosquito-bite, but the knowledge was of little more than academic value until engineers—as a side issue to the building of the Panama Canal—developed a successful method of mosquito control. In our grandfathers' time a new disease became recognised. They called it "Boulogne sore throat." The doctors investigated it, traced it to air-borne bacteria and re-named it diphtheria. That the disease is no longer the menace it once was can be placed in very large measure to the credit of the sanitary and sewage disposal improvements developed by the engineer. The engineer, it should be noted, has entered into these beneficent works in many ways, all complementary and all essential. It is not sufficient for the civil engineer to secure an adequate source of water supply by building dams and reservoirs. Without the aid of the mechanical engineer's pumps and power plants, the chemical engineer's dosing plant and the products of the excavator manufacturers, the valve makers and the pipe foundries the water could not be brought from the hills and the rivers and distributed to the large and small centres of population in the quantity and in the condition which medical research indicates to be necessary for their health.

The engineer may in these matters regard himself quite justly as the executive of the medical profession. He should be careful not to exceed the responsibilities of that position. Recently there have undoubtedly been signs that he is inclined at times to stray from the executive into the directive sphere, and to assume the initiative in matters affecting the public health without the guidance and encouragement of the medical profession. It seems to us that the time is ripe for the doctors to make a careful study of all that is imported in the question: How far are modern engineering developments, of a kind impinging upon our bodily welfare, beneficial or inimical to public health? Is it to the ultimate good of the race that we should drink water, breathe air, and eat food freed from the last trace of disease-producing impurity? We have an uneasy feeling at times that we may be proceeding too far in these directions and that we may be laying up serious trouble if not disaster for ourselves or our immediate descendants. To live in a rarefied atmosphere free from germs may enable us to escape from immediate disease; but unless we can carry that atmosphere with us wherever we go, or alternatively wage an effective "microblitzkrieg" not only on the germs within range of our apparatus but throughout the regions in which we make contact with others, it would seem just possible that we are likely to secure present immunity at the expense of the ultimate weakening of our resistance to disease when we come to be exposed to it. The human body is in many ways analogous to a machine, but there is a distinct danger of engineers coming to regard it purely as a machine. It is not; it differs from a machine in at least one very outstanding respect, its ability to adjust its characteristics and its reactions to the circumstances surrounding it. If we supercharge it with pure water, pure food, and pure air it will adapt itself to these things after a time and will lose its capacity, inherited from past generations, to absorb without much hurt to itself impure water, food, and air. It is true that if these pure supplies were withdrawn from it, the human body by virtue of its adaptability could recover its power to handle impure supplies. It is, however, very much easier to dispense with the necessity for exercising powers of resistance than to recover those powers after they have been lost through disuse. The process of re-adaptation to impure supplies might well prove fatal to the individual or the generation called upon to undergo it. On these and cognate subjects the medical profession might now with much advantage provide some authoritative guidance. Is it, we wonder, in a position to do so?

The Scrap Position

THE Minister of Supply has made the Control of Iron and Steel (No. 7) (Scrap) Order, 1940, Direction (No. 3) increasing the maximum prices for scrap iron and steel as from May 6th, 1940, to meet the recent increase in railway charges. In the case of scrap iron and steel for the manufacture of steel ingots, otherwise than in electric arc furnaces, the maximum prices have been increased by 1s. 6d. per ton for consumers in South Wales (West); by 1s. per ton for consumers on the North-West Coast, and in Cheshire (including Shotton), Brymbo, and South Wales (East); by 6d. per ton for consumers in the Midlands (except for two grades of cast iron which are increased by 1s. per ton); and by 9d. per ton for consumers in all other districts. All other grades of scrap are also increased by 9d. per ton. The problem of providing sufficient iron and steel scrap to maintain the huge production of iron and steel is causing concern to the Control and to steelmakers. Considerable quantities have been purchased in the United States, but naturally the authorities are reluctant to buy more from abroad than is absolutely essential, since a heavy expenditure upon this material must affect the exchange position of the country, to say nothing of using shipping badly needed for other commodities. Not long ago the Control raised the prices of scrap in the hope that it would produce more material from home sources, and it also set in motion a campaign for the collection of old iron and steel in large or small quantities all over the country. The result of this action has been that the supplies of iron and steel

scrap have considerably increased, but not to such an extent as to relieve the steel trade from anxiety. A house-to-house and farm-to-farm collection such as was instituted is chiefly useful in providing what is known as "light" scrap. The higher prices paid for this material have resulted in greater activity being shown by the itinerant collectors who travel around the country in lorries picking up old iron wherever possible. A point has now been reached, however, where the supplies from this source have been much depleted, and there is an outcry that the iron railings in our parks, squares, and in front of private houses should be pulled down and sold to the steel trade. This seems to be going rather far, since it would obviously be necessary in the majority of cases to provide a substitute for the railings, perhaps at considerable expense. The situation for the time being is not dangerous. Good supplies have arrived, and the merchants' yards are better filled than for a long time. Large tonnages are passing to the furnaces, however, and there is an element of uncertainty in the future. The various steel producing districts in Great Britain are somewhat irregularly supplied with scrap, and whilst there are complaints in some directions that production is handicapped by a shortage, in others the position is regarded with more complacency.

Obituary

DR. ALFRED J. AMSLER

THE death occurred on April 2nd of Dr. Alfred J. Amsler, whose name was well known throughout the whole world in connection with the invention and development of numerous scientific and mathematical instruments, and of various machines for the testing of materials. Dr. Amsler died in his eighty-third year at his home in Schaffhausen, Switzerland.

His father, Professor Jakob Amsler, was the inventor of the well-known polar planimeter familiar to all engineers. Alfred entered his father's business in 1885, and at first devoted himself to the development of mechanical integrators and produced a number of elegant variations including instruments for measuring moments of areas up to those of the fourth order, $\Sigma \delta a r^4$. At the same time he manifested his high mechanical genius in other directions. One invention which he produced in his early career was an automatic machine for sorting cartridge cases as they came from the drawing presses, the sorting consisting of arranging them with the bottom ends upmost, ready for the fixing of the percussion caps or with the open ends upmost ready for filling with the charge. The construction of machines for this purpose involved many difficult problems, but they were solved by young Amsler so satisfactorily that some of the machines which he supplied fifty years ago are still in use to-day at the Swiss Federal Arsenals. Another machine which he produced at the opening of his career was a semi-automatic multiple dividing machine for the logarithmic division of slide rules.

Soon, however, Alfred Amsler began to manifest an interest in the field which was to become the principal one of his work, the design and construction of machines for testing materials. His father had already entered that field, first with the development of certain power measuring instruments and dynamometers, and then, as a direct outcome, of a few material testing machines. In these machines Jakob Amsler departed from the established means of measuring the applied load, namely, by means of a beam scale, and adopted the hydraulic principle. The friction between the measuring piston and its cylinder was a source of trouble and error, but following the method employed by the celebrated French physicist, Amagat, his contemporary and close friend, Jakob Amsler made use of a piston without packing, ground into its cylinder with very high precision.

One of Alfred Amsler's first tasks in this new field was to devise an instrument for indicating with accuracy the high pressures set up in the measuring cylinder. In conjunction with his father he developed the mercury load indicator whereby with the aid of frictionless differential rams the high oil pressure was transformed into a moderate mercury pressure, the magnitude of which could be measured by means of a mercury column or recorded on a diagram by means of a float mechanism.

For a number of years the hydraulic principle was employed in the Amsler testing machine merely for measuring the load while the load itself was applied in the customary way by means of a screw and gear wheel mechanism. Then Alfred Amsler developed the idea of using the hydraulic principle for both purposes. This development enabled the control of the load and its measurement to be centralised at a position remote from the machine itself. To give it effect a number of new problems had to be solved, one of the most important being the construction of an oil pump which would deliver oil at several hundred atmospheres pressure without serious pulsations. The final solution of this problem consisted of a pump with a low pressure plunger driven by a crankshaft and a high pressure plunger driven by a cam. Simultaneously Alfred Amsler developed an oil-delivery regulator and the so-called "pendulum dynamometer" which served as an alternative to the mercury load indicators. In the pendulum dynamometer he applied for the first time the principle of rotating the measuring piston for the purpose of overcoming its friction to linear movement.

In connection with the development of testing machines, Alfred Amsler produced his "standardising box" for checking the accuracy of the load indicators. This "box" consisted of a hollow steel cylinder filled with mercury and fitted with a plunger attached to a micrometer screw by means of which the quantity of mercury displaced from the interior of the cylinder when stress was applied could be measured. In some recent Amsler testing machines the elastic deformation of the columns of the machine itself is used as a means of measuring the applied load.

Impact, abrasion, and fatigue testing machines next claimed Alfred Amsler's attention, and in each he made notable advances. In particular there should be mentioned his "pulsator" fatigue tester in which the cyclical load variation is produced by a pulsating oil pressure. As a logical development of his work on testing machines he turned towards the improvement of dynamometers. His first essay in this direction was the rotation dynamometer for measuring the power transmitted in machine tools. Subsequently he developed his torsion dynamometer for measuring the power of turbines running at high speeds. His greatest fame in this direction, however, is to be sought in the work which he did in developing the railway dynamometer car. Jakob Amsler had made a beginning in this direction in 1900 by constructing certain recording devices for use on railways. Alfred Amsler developed the subject and applied the hydraulic measuring principle to it. In its modern form the Amsler railway dynamometer car equipment includes devices for measuring the tractive and braking forces, the speed and the work done by the locomotive in its cylinders and at the coupling.

In addition to his work in the fields we have mentioned above, Alfred Amsler developed a number of other devices including hydraulic current meters, recording and integrating liquid gauges and equipment for automatically recording the condition of railway tracks.

He was undoubtedly the worthy son of an able father. Undoubtedly, too, the world has lost by his death an inventive brain of a rare and refined character.

CHARLES FARADAY PROCTOR

BY the death of Charles Faraday Proctor, which took place on Saturday, May 4th, at his home, 77, St. Mary's Grove, Chiswick, at the age of 79, the British electric lamp industry has lost one of its early workers, who did much to develop the industry. Charles Proctor was born at Newcastle-upon-Tyne, and received his education at private and public schools and institutions in that city. He served an apprenticeship of four years in the various departments of the works of Henry Watson and Sons, and then spent a further year in the laboratories of the late Sir Joseph Swan. In 1881 he was sent to Paris to assist in the setting up of the first factory in France to be specially designed for the production of incandescent electric lamps, and was appointed assistant manager for the Swan Company. Four years later he went to Lille as assistant manager of the Swan Factory, and he returned to Paris in 1888 to design and equip the large new lamp works of the Swan Company in Paris. The following year he was awarded the Medal of the Paris International Exhibition for Lamp Making. In 1891 he devised and patented a method of constructing incandescent electric lamps in which the filament is first mounted on a flanged tube of glass, thereby enabling it to be sealed into the bulb by machinery, instead of being assembled by hand. Mr. Proctor was appointed the manager of the Edison and Swan Company's Works at Ponder's End in 1893, and in the years which followed he took out many patents for improved lamp fittings, including the present design of bayonet lamp holder. He went to Newcastle-upon-Tyne in 1900, to take up the position of engineer and assistant manager of the Edison and Swan Lamp Works at Benwell, Newcastle-upon-Tyne. About 1914 Mr. Proctor left the service of the Edison and Swan Company, and joined the General Electric Company, serving in Cardiff as the central station engineer on the G.E.C. staff. In 1916 he was transferred to the Osram Robertson Lamp Works of the General Electric Company, at Hammersmith. He was a member of the Institution of Mechanical Engineers and the Institution of Electrical Engineers and for some years was the Chairman of the North-Eastern Centre of the Institution of Electrical Engineers.

GERALD WILLIAM PARTRIDGE

IT is with deep regret that we have to record the death on Friday, May 3rd, at Woldingham, Surrey, following a short illness, of Gerald William Partridge, who was associated with the London Electric Supply Corporation, Ltd. for over half a century, rising from assistant engineer to engineer-in-chief, and managing director of the Corporation. A pioneer of the electric lighting industry, his death leaves a gap in the ranks of those who did so much to develop London's electric supply systems. He was born in June, 1864, and received his early education at St. Marks School Windsor. In 1882, he went to Germany for two years to the Technical College at Essen, where he began his scientific training. On his return to England in 1884, he entered the Hammond Electrical Engineering College at Red Lion Square, where he gained practical experience in electrical engineering work. After leaving college he joined the Anglo-American Brush Engineering Company, and spent three years going through the various shops and departments. For a short time he was a pupil in the office of Messrs. Woodhouse and Rawson. In 1888, he was appointed assistant engineer of the London Electric Supply Corporation, which had then been formed to take over the Grosvenor Gallery installation, and to carry out Dr. Ferranti's larger scheme for high-voltage distribution from the new station at Deptford. In 1892 Mr. Partridge was appointed chief electrician of the Corporation, and two years later he became second engineer with charge of the distribution station, the installation department, testing and mains. In 1899 he succeeded Mr. P. W. d'Alton, who was appointed chief engineer when Dr. Ferranti left the company, as engineer-in-chief of the Corporation. Later he became managing director of the company, and he continued to hold that position until his death.

At the Commemoration Meeting of the Institution of Electrical Engineers which took place on February 23rd, 1922, to commemorate the first ordinary meeting of the Institution (then the Society of Telegraph Engineers) on February 28th, 1872, Mr. Partridge read a paper in which he referred to his early experiences with the Anglo-American Brush Company, and his work under Dr. Ferranti in the founding of the London Electric Supply Corporation in 1887, and the difficulties experienced with the transformers and high tension mains. He it was who overcame the trouble experienced in charging the 10,000 volt mains, by the introduction of charging gear. The mains, we may recall, consisted of two concentric brazed copper tubes of equal cross sectional area separated by paper insulation impregnated with ozokerite wax, which were made in 20ft. lengths. The cables were enclosed in a $2\frac{3}{8}$in. diameter thin iron tube with a brazed seam which was filled with wax. Following his paper, Mr. Partridge presented to the Institution a 10,000 volt coil, transformer, cables and other apparatus as a record of that pioneer installation.

Mr. Partridge kept in close touch with the work of the scientific institutions and was a member of the Institution of Civil Engineers and the Institution of Electrical Engineers. He served on the Council of the Institution of Electrical Engineers for some years, and was elected Vice-President in 1917. In later times he devoted his time to the administration and financial sides of the electric supply industry, and as well as his position with the London Electric Supply Corporation was also director of many electricity undertakings.

New Metallurgical Research Laboratories

IN a Journal note published in last week's issue, we made reference to the official opening on Tuesday, April 30th, of the new research laboratories of High Duty Alloys, Ltd. The opening ceremony was performed in the presence of a large company by Sir Henry Thomas Tizard, F.R.S., Rector of the Imperial College of Science and Technology, South Kensington, and Chairman of the Aeronautical Research Committee. The new laboratory buildings have been designed to meet the requirements of the firm, in its business as producer of light alloy metals, to control works practice, and to provide an early solution of manufacturing problems. In addition, research work is carried out on problems relating to marketing, production and buying. Information is also provided for the allied Engineering Development Department, whose task it is to work out new applications for light alloys, and to improve methods of fabrication.

Laboratory Buildings

The buildings of the new laboratories consist of four bays, each having a length of 140ft. and a span of 50ft. Along the front of the bays there is a two-storey block of administration offices, while at the back are the various outbuildings, housing the services, cloakrooms, and air conditioning and heating plants. The bays are divided into various departments by hollow brick walls, and where necessary ceilings are provided. The construction is such as to give natural roof lighting in all departments, and also to permit the concealment of all the ducts for the ventilation and fume extraction systems. The wall and floor finishes are adapted to the purposes needed, and we noted cork panelling for silence, aluminium lining for the damping laboratory, and lead lining for the X-ray rooms. As will be seen from the illustrations reproduced on page 436, the flooring has been chosen to suit the various laboratory requirements. The laboratory services are entirely self-contained and are independent of the works supply for gas, electricity, water, compressed air, &c. Electricity is available both on three-phase and single-phase circuits, and special distribution boards make available low pressure supplies at a range from 2 volts to 100 volts.

Library and Information Department

Included in the laboratory building is a well-stocked library, with text books and technical publications which are indexed and classified. This department produces an abstract of information on metallurgy and other cognate subjects which is issued and circulated in the form of a fortnightly Bulletin. Attached to the library is a well-equipped lecture theatre, designed to accommodate about 100 students, and also a conference room, which when needed can be used as an extension to the theatre.

Spectrographic Laboratory

An interesting laboratory is that devoted to the analysis of complex aluminium base alloys by spectrographic means. There are two quartz spectrographs by Adam Hilger, Ltd., and Zeiss, with special cameras and four microphotometers which operate on the photo-cell principle, and enable the densities of the principal spectrum lines to be accurately measured. Adjacent to the laboratory is accommodation and equipment for the preparation of the specimens and the development of the spectrographic plates. For qualitative analysis two spectrum viewers and enlargers are provided. In this department the routine analysis of a considerable proportion of the aluminium alloys produced by the firm is carried out—in particular the analysis for magnesium, silicon, and iron. At present some hundreds of melts are being dealt with a day.

Corrosion and Protection Laboratory

This laboratory provides facilities for corrosion resisting testing and equipment for the application and testing of various protective treatments. The apparatus provided includes a large continuous sea water spray booth, intermittent sea water spray cabinets, and a mechanical apparatus, shown in our illustration, for the alternate immersion of specimens in various corrosive media. An apparatus for testing the resistance of materials to erosion is also provided. The protective treatment plant utilises the most up-to-date processes for electro-deposition, paint and rubber spraying.

Instrument Workshop

The instrument workshop attached to the laboratories is furnished with a wide range of machine and hand tools designed to work to the very close limits required in these types of instruments. Work benches are also provided. A part of the workshop is used for the maintenance of the large number of pyrometric installations in the company's works and the manufacture and standardisation of thermo-couples. Adjoining the workshop is a special calibration room.

X-ray Crystallographic Laboratory

In this department X-ray methods are employed to determine the extent and effects of cold work and the crystal orientation in cast, worked, and heat treated samples of production materials. Problems relating to recrystallisation, grain growth, and grain size are also investigated. The equipment includes a crystal analysis X-ray unit furnished with a number of X-ray tubes having targets of various materials, and also a number of special cameras adapted to the investigations undertaken.

Damping Laboratory

Investigation into the damping capacity or internal friction of materials is one of the most recent branches of metallurgical research. The laboratory is equipped with the most modern apparatus for research in connection with damping problems.

Colorimetric Laboratory

Although colorimetric analysis by comparing test solutions against standard solutions in white light has been practised for many years it is only comparatively recently that methods of absolute colorimetry by means of the accurate measurement of the absorbtion of monochromatic light in a given length of test solution have been technically applied. Standard solutions are used, thereby removing possible sources of error, and in the case of complex alloys it is possible to eliminate the influence of other components present in the alloy by the choice of a suitable wave-length. In this laboratory there are several types of highly accurate spectro-colorimetric instruments and satisfactory methods have been developed for the quantitative analysis of the iron and titanium contents of light alloys.

Experimental Testing Laboratory

In this department long-range research on various lines is carried out, and facilities are available to make high-accuracy static and dynamic mechanical tests. At the time of our visit there were in the laboratory two specially designed high-temperature vacuum furnaces, one of the electrical resistance type, and the other a 20 kW high-frequency induction furnace. The mechanical testing equipment includes a 15-ton Avery beam type testing machine, two Amsler-Wöhler fatigue testing machines, an N.P.L. rotating fatigue testing machine, a battery of creep testing machines, and an Avery-Brinell hardness tester.

Metallographical Laboratory

The work in this laboratory includes the metallographic examination of forging ingots in order to eliminate those unsuitable for forging. Also an examination of finished components for breakdown of structure, grain flow, &c. as a check on forging conditions, and the micro-examination of all types of alloy components for overheating in heat treatment is undertaken. Besides the main metallographic examination room, the department includes two rooms for the preparation of specimens, an etching room, a photographic studio and two large dark rooms. The principal metallographic equipment includes a Vickers projection microscope, a Zeiss Neophot microscope, and Beck microscopes for bench use, and apparatus for large specimens and complete components.

Heat Treatment Department and Rolling Mill

In this department the equipment includes two Wild-Barfield and one Siemens electric-resistance furnaces with forced air circulation and an interesting recirculation gas furnace by the Templewood Engineering Company, Ltd. There are also a number of small electric muffle furnaces. All furnaces are complete with electrical controls and recorders. The department also includes a small rolling mill by W. and H. A. Robertson and Co., Ltd., which is used for the preparation of strip for testing purposes. In the laboratory the heat treatment characteristics of various alloys are studied, along with hot and cold working characteristics.

Experimental Foundry

In close connection with the heat treatment and rolling mill department is the experimental foundry, which is equipped with various types of gas-fired, electric-resistance, and arc melting furnaces. Attached to this department is a room housing the sand testing equipment in which daily tests are made of the moulding sands used in the various works foundries. The activities of the department include the preparation of experimental alloys, the investigation of casting properties, the development of casting methods and technique, the study, development and control of moulding sands, and the preparation of standards for analytical departments.

Chemical Laboratory

The chemical laboratories occupy one complete bay of the building, and are designed to carry out some hundreds of complete analyses per day. In the design particular care has been taken to provide adequate working space and allow for the easy flow of work. With regard to ventilation, besides the normal air conditioning arrangements common to the whole building, designed to give twenty changes of air per hour in this department, there is a special fume extraction plant designed to effect 130 changes per hour, extractors being arranged at all special points. A separate laboratory, also illustrated on page 436, is provided for routine electro-chemical analysis. In it is a five-bank electrolytic apparatus having a capacity of 150 determinations per hour. It has a totally enclosed motor control for each of its 50 units with independent transformers and rectifiers and electrically heated controlled hot plates. Attached to the chemical laboratories is a spacious balance room containing 24 Becker analytical balances, of which seven are of the prismatic type. The remainder of the bay is occupied by stores and still room with an automatic still and storage tanks of 300 gallons capacity.

Mechanical Testing Laboratory

In this department there are three Amsler hydraulic universal testing machines, two of which are of 15 tons and one of 30 tons capacity. There is also a 4 tons capacity Avery sheet testing machine, a Hounsfield Tensometer and Brinell hardness testing machine, along with various types of extensometers and the necessary gauges and testing instruments.

Radiographic Laboratory

This laboratory contains a very complete equipment of Philips X-ray tubes of 100 kV, 150 kV, and 200 kV capacity, each of which is housed in a separate lead-lined room with the controls outside. An unusual feature of one installation is the screening table, which is equipped with a belt conveyor system. The castings are fed on to a belt and pass under the viewing screen for examination. By means of remote control, the operator can manipulate the castings under the screen to any required position and mark any defects by means of a colour spray. Mechanism is provided for rejecting defective castings. In connection with the department there is a large dark room and a drying room which is maintained at 90 deg. to 95 deg. Fah. to permit the rapid drying of radiographs.

Conclusion

In conclusion, tribute must be paid to the architect, Colonel A. L. Abbott, F.R.I.B.A., the builders, Y. J. Lovell and Son, Ltd., and also the principal contractors who, despite the difficult circumstances of the past few months, have completed and equipped the laboratories in less than one year. The air conditioning plant was designed and installed by Vacuum Refrigeration, Ltd., of London, and the laboratory furniture was supplied by W. and J. George, Ltd., proprietors of F. E. Becker, Ltd., of London and Birmingham.

"Unit-Construction" Trolleybus

A TROLLEYBUS manufactured by the Associated Equipment Company of experimental type incorporating new constructional features in the underframe was placed in service by London Transport in February, 1938. As a result of the experience gained with this vehicle, a further 25 were sanctioned, and these vehicles have recently been allocated to the West Ham depot of this undertaking. As in the experimental vehicle, the bodies were constructed by Weymann's Motor Bodies, Ltd., of Addlestone. These new trolleybuses

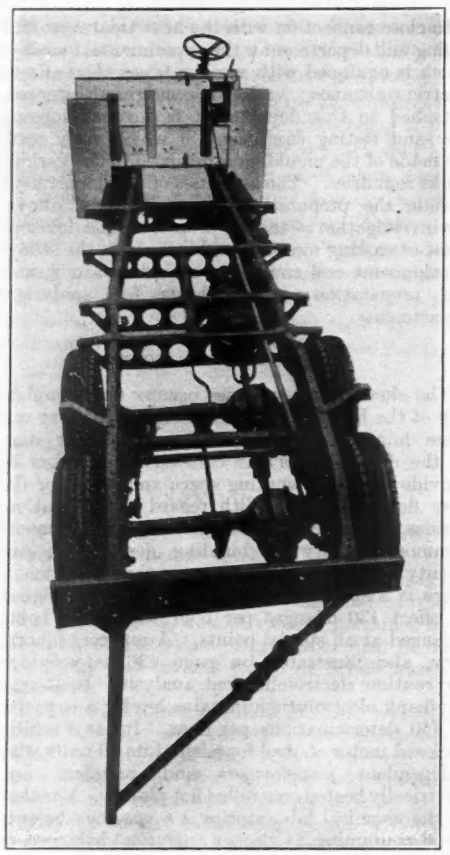


FIG. 1—TROLLEYBUS CHASSIS

are of what is termed "unit construction." The underlying principle of their design is rigid connection of the body side-pillars to the underframing or chassis, and for this purpose cross-members and outriggers are arranged to coincide with the standard body pillar positions. The conventional floor bearers are eliminated. With this method of building, it is considered that the rigidity of the body, combined with the strength of the chassis, will result in a stronger mechanical and, to a slight extent, a lighter form of construction.

It will be noticed in Fig. 1 that the underframe or chassis consists of a light-pressed steel frame of

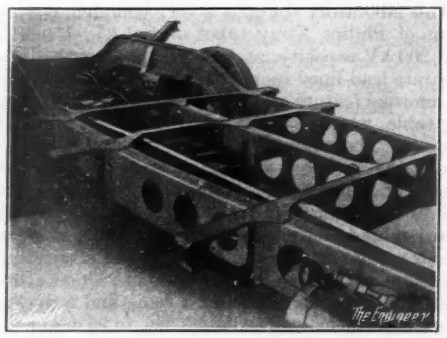


FIG. 2—MAIN CHANNELS AND CROSS-BEARERS

deep section. The material employed is actually little more than one-half of the thickness of the conventional frame. On the more highly stressed portion an angle is riveted into the top and bottom sections, in order to increase the strength of the main longitudinal members at the essential points without unduly adding to the weight of these members. Trepanned holes in the members remove unnecessary metal. Light-pressed cross-members with outrigger extensions protruding beyond the frame side-members are coincident with, and form an attachment for, body pillars of standard type. The second engraving, Fig. 2, shows how this result has been achieved with a minimum of welding. The saloon flooring lies directly on the cross-members.

The extremity of the chassis outrigger bracket is of similar section to that of the normal body cross sill, and the attachment of the pillar at this point is, therefore, precisely the same as on normal bodies. This arrangement is shown in Fig. 3, the pillar with the normal cleats or brackets being riveted to the underframe outrigger. The absence of welds at this point—a desirable feature with thin, highly stressed sections—will be particularly noted. A light angle is also arranged in the corner of the pillar and outrigger, and the transverse floor boards are then fitted. In Fig 4, reproduced from a photograph of a model, are shown short pillars and a bulkhead merging the body and underframe, which are integral and which in the "unit construction" plan cannot at any time be separated. Particular attention has

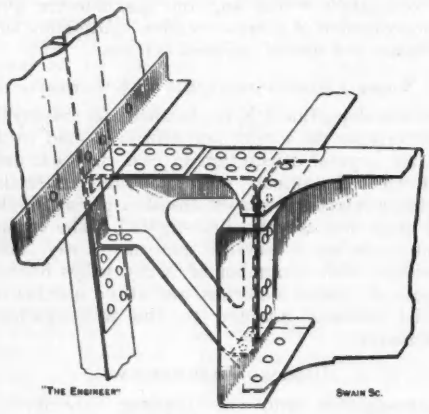


FIG. 3—ATTACHMENT OF BODY PILLAR

been given to the bulkhead attachment. The flanged foot of the body bulkhead is arranged to coincide with a similar top flange on the underframe cross-member immediately underneath, and the two are securely riveted together. The rear of the frame terminates in a deep cross-member extending the full width of the body. This member fulfils the dual purpose of a cross-member and a step riser, and also forms a substantial rear bulkhead to which corner and door pillars are attached.

Welding has been kept down to an absolute minimum, and the design of underframe is generally on conventional and tried lines, whilst the rigidity of the body side panel construction is usefully employed for augmenting the strength of the underframe. This method of construction, it is felt, overcomes one of the major difficulties associated with the design of the "chassis-less" type of vehicle, in which

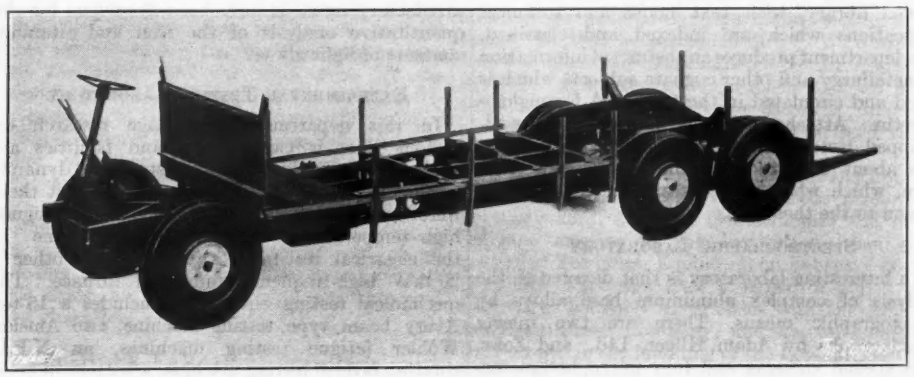


FIG. 4—MODEL SHOWING ATTACHMENT OF BODY AND UNDERFRAME

endeavour is made to use the deep, side body panels as the main longitudinal members replacing the chassis side-member.

To appreciate the difficulty involved, the firm states that on a laden, six-wheel trolleybus, the loading is concentrated at the rear trunnion attachment of bogie to body—at two points—and is slightly in excess of eight tons, whilst a load of over five tons is concentrated on the front axle connection to the body. At the trunnion, the body side-girder is of considerably reduced depth because of the intrusion of the wheel arch. Furthermore, the actual trunnion attachment is some 18in. inside the body panel, with the consequence that a twisting moment is introduced at this very highly stressed point. Again, the front axle connection is at a point where the front wheel arches cut deeply into the body side-girder, and on the offside the driver's cab door cuts completely through the body side. The result is that "sub-chassis" have to be introduced at both these points, as well as for the motor suspension. This necessity detracts somewhat from the simplicity of the design and makes the term "chassis-less," as applied to this type of vehicle, somewhat inappropriate.

South African Engineering Notes

(By our South African Correspondent)

New Steel Works for the Union

MENTION has already been made in these columns of a scheme for a new steel works in the Union of South Africa, and Dr. H. J. van der Bijl, Chairman of the South African Iron and Steel Industrial Corporation, Ltd., has now an outline of the latest development. Dr. van der Bijl states that a considerable expansion of the South African iron and steel industry, including a new steel works with a capital of between £5,000,000 and £6,000,000 is planned. Dr. van der Bijl declined to disclose where the new steel works would be erected as it was not desirable to make this information public at present.

£13,000,000 for Union Railway Works

In presenting his first Budget to the House of Assembly at the end of February, the Minister of Railways, Mr. F. C. Sturrock, announced that new works to be undertaken during the year 1940–41 would involve an estimated total expenditure of £13,000,000. This includes £5,748,000 to be spent in the next three years by the South African Railways in building coaching stock and goods wagons to meet the increasing demand for rail transport and to replace vehicles which are already obsolescent. The three-year programme will place 500 coaches and 8000 trucks on the lines. All but 10 per cent. of the stock will be built in South Africa, the bulk of it in the various railway workshops. The coaches will cost £1,716,000 and the trucks more than £4,000,000.

The Vaal Dam

The Irrigation Department's report refers to the successful completion of the Vaal Dam and says its usefulness has been well demonstrated. At the end of the period under review 126 settlers had been placed under the scheme, an increase of 96 over the previous year. The climatic conditions at the settlement are favourable and the initial results of the scheme are encouraging. Over £376,000 was spent during the year, making the total expenditure on the Vaal-Hartz settlement scheme £1,852,000.

Electricity Supply Commission Loan

The Electricity Supply Commission, of which Dr. H. J. van der Bijl is Chairman, is raising a loan of £2,500,000 issued at 98½ and yielding 3¾ per cent. interest which will be used for extending the Klip, Vaal, Congella, Durban, and Colenso power stations. The Commission is building continually to keep abreast of the demand for power, and its programmes entail the spending of between £2,000,000 and £3,000,000 on an average yearly. The new Vaal station, it is expected, will be brought into operation in 18 months' time.

Motor Trade Recovering

There are abundant signs that the motor-car trade is recovering from the doldrums in which it was becalmed after the outbreak of war. Garages are working at full pressure and the second-hand trade, for many years the bugbear of the industry, is busier than it has been for years.

Industrial Expansion

The Great War brought about an immense development of industry within South Africa. The expansion of the engineering shops on the Rand and elsewhere was due to the necessity for carrying out all kinds of jobs within the country, and the cutting off of oversea supplies in many directions gave an impetus to secondary industry, generally in the sub-continent. So much was done then that as great an advance can hardly be expected during the present war, but there are certainly opportunities for making

the Union more self-dependent. A period of industrial expansion lies ahead if advantage is taken of new openings that present themselves. The effort will demand the raising of capital, and if permanent results are to be obtained new undertakings will have to be planned with foresight as well as energy. The Government has at once recognised the need for sound direction as well as for financial aid and has set up an Industrial Corporation with a capital of £5,000,000 which will strive to give a useful lead in directing expansionist ideas into the best channels. The board controlling will be composed of men selected for their ability in business or administration and their experience in industrial, commercial, or financial affairs. The Government will nominate a majority of the directors, but no members of Parliament will be allowed to sit on the board. The Government is also giving very earnest attention to the need for assisting in the expansion of the base mineral resources of the country, having been greatly impressed by the statement of Mr. Wallack that an expenditure of £1,000,000 would lead to the expansion of the value of the base metals production of the Union from the present figure of between 2 and 3 million pounds per annum to as much as £20,000,000 per annum.

Copper Outputs Increase Largely

Since 1930, about £25,000,000 has been spent in developing the copper mines of Northern Rhodesia, and by the end of 1939 they had produced copper worth £52,000,000. Before the outbreak of war the mines were producing about 18,000 tons monthly and the price was about £56 per ton. The production has now reached 32,000 tons per month, and the price is about £60 per ton. If necessary the four mines now working could double their output and there is in reserve the N. Changa mine, reputed to be one of the richest in the copper belt of Rhodesia, which can be put into production at once if necessary. Copper mining in Namaqualand has been dormant for nearly 30 years, but now the copper mine at Nababeep has been re-opened and has new plant. Two mill units have begun operating, and 250 Europeans and 750 coloured workers are employed. The British Ministry of Supply has offered to take the whole output during the war period.

Sixty Years Ago

CLEVELAND IRON

THE inquiry into the Tay Bridge disaster was complicated by the fact that the court had not only to determine the cause of the collapse, but also to decide whether the bridge, if repaired, would be safe. As to the cause of the disaster, the Board of Trade argued that the bridge had been improperly designed and badly constructed. Sir Thomas Bouch, through his counsel, submitted that the bridge was well designed. The contractors, Hopkins, Gilkes, and Co., asserted that the workmanship and material were excellent. Sir Thomas Bouch was unable to support the view that the contractors had built the bridge badly or used bad materials because to have done so would have been to have accused himself of passing faulty work. The contractors could not support the view that the bridge was badly designed because in a number of important respects the original design had been modified at their suggestion and in accordance with their recommendations. The explanation advanced to account for the disaster by Sir Thomas Bouch avoided the dilemma presented by these considerations. His theory was that one of the carriages and the guard's van of the ill-fated train had been derailed by the wind, that they had been thrown against one of the side girders, and that the girder, giving way, had induced the collapse of the remainder. Mr. Bidder, Q.C., acting for Sir Thomas, sought to extract support for this theory from some of the expert witnesses called before the Court, but was unsuccessful. The circumstantial evidence which he adduced in its favour was quickly shown to be either ambiguous or capable of being explained in a contradictory manner. For a time it seemed that one of the possible causes of the disaster might be found in the bad quality of the iron—from the Cleveland district—used in constructing the bridge. That opinion seems to have been based on the evidence tendered by certain of the workmen. In our issue of April 30th, 1880, however, we wrote that there could now be no doubt that the iron used was of far better quality than was at first supposed. Mr. David Kirkaldy, we said, had tested some of the tie bars and had found that they had broken under a load ranging from 24·8 to 26·1 tons per square inch. In our succeeding issue we published a letter from a Stockton-on-Tees correspondent in which the hope was expressed that this revelation of the strength of the tie bars would lay once for all the damaging belief that had been growing up concerning the poor quality of Cleveland iron. . . . There the matter might have rested but for the fact that somehow or other we had misquoted the results of Mr. Kirkaldy's experiments. In a letter which we published in the same issue as that in which our Stockton correspondent's appeared he stated that the tie bars had actually broken under a load of from 19·31 to 21·09 tons per square inch, that the contraction of area varied from 10·53 to 17·37 per cent. and that the elongation on 10in. was from 6·6 to 12·3 per cent. He left us and our readers to draw our own conclusions from these figures.

Emergency Sub-Stations

IN accordance with the provisions of the Civil Defence Act, the Central Electricity Board has provided in various parts of the country special equipment which can be used to reduce to a minimum the time required to re-establish supplies after a major electricity supply failure. This material includes transformers, switchgear, cables, overhead line equipment, &c. The transformers, which vary in size from 5,000 kVA to 20,000 kVA, are suitable for all the main voltages in use in this country, and special units are provided for certain areas where two-phase working is used. They are stored completed in every respect and can be despatched to site by either rail or road complete with cooling gear, bushings, and conservators in position, the only parts requiring fitting on site being such brackets and insulator supports as may be necessary to meet actual site requirements. These brackets, &c. are of simple construction and can easily be assembled in less than one hour. The transformers over 10,000 kVA capacity are of the O.F.B. type and the cooling equipment supply is provided by means of an auxiliary transformer contained on the main unit. The spring operated switchgear is of three types, 66 kV, 32/22 kV., and 11/6 kV. Its design permits rapid erection either indoors or outdoors and incoming or outgoing connections can be by cable or overhead lines. Single-core cable is used and is stored complete with all accessories, use being made of specially designed emergency cable joint boxes with cold setting compound.

The overhead line material provides for lines ranging in voltage from 33 kV to 132 kV. The necessary jumpers are provided to enable temporary connections to be made to existing bulk supply lines, and to the spare transformer and switchgear, through which the necessary local supplies can be given.

In view of the fact that the cable jointing might take up a very considerable portion of the time when making emergency supplies available, the switchgear can be so arranged that those parts which require connection to feeder circuits can be completed first so that the cable organisation can then proceed with its work without inconveniencing the general erection of the remainder of a sub-station.

We recently had an opportunity of seeing a typical emergency sub-station in which this spare equipment is used. For it a 33 kV overhead line had been tapped and the various parts of the equipment installed on a framework built up of angle iron specially fabricated for rapid and easy erection by unskilled labour. A 20 MVA transformer was connected up to the line and its output passed on to a four-bay switchboard comprising one transformer switch and three outgoing circuits.

The connections to the transformer were brought out opposite to those of the feeder circuits and the first feeder circuit arranged for three single-core cables, the structure carrying the sealing ends being brought up close to the switchgear structure. This was not the preferred assembly but was done to illustrate the small amount of ground taken up in cases where site restrictions prevail. The second feeder circuit was arranged at the preferred spacing, and provides for three single-core cables per phase, whilst the third feeder circuit was arranged to take an overhead line connection.

The sub-station inspected was erected as if under emergency conditions, except that it was not considered worth while to work during the hours of darkness. The material was picked up at points 20 miles away from the sub-station site, the loading of the material starting at 7.30 a.m. on the first day. The complete station was made alive at 6 p.m. on the second day, the actual time taken for erection being 19 working hours. No actual feeder cables were connected, but the two gantries carrying the cable work were completed and would have been available within three hours of the start of the general erection so that some sixteen working hours were left for the cable people to complete their work.

L.M.S. "WAR VETERAN" ENGINES.—Eighty-one of the 7644 locomotives in use on the L.M.S. Railway are "active service veterans" of the last war. They are the survivors of 246 locomotives belonging to constituent companies of the L.M.S. which were sent overseas in the last war for transport duty on the Western Front and elsewhere. Some of these 246 engines did not return from the war, and others have since been withdrawn from traffic. The 81 surviving engines, which are now working in essential transport services on the Home Front, comprise 38 which originated on the former London and North Western Railway, 18 of the former Lancashire and Yorkshire Railway, and 25 Scottish locomotives.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE SELECTION OF APPRENTICES

SIR,—I have read with much interest your leading article on the important subject "The Selection of Apprentices," and while I generally agree with your sentiments as applied to this particular class of individual, I cannot help feeling that those who casually read it, with its allusions to "mechanical toys and games," will gain the impression that you are wholeheartedly opposed to any process of psychological selection.

The country is at war! We require a maximum effort in a minimum of time, and I submit for your consideration that though the principle of "trial and error" may have its points in training that is likely to be extended over a number of years, in days when the exigencies of war necessitate firms undertaking work of which they have no experience it is vital to have some positive selection, and to employ rational means to reduce the number of misfits. Too often the results of the "hit and miss" policy are bitter complaints of "square pegs in round holes," and equally often the unfortunate individuals are blamed rather than the pernicious system which produces the anomaly.

Fortunately much spade work in real psychological selection has already been performed in the confectionery and other businesses where certain qualifications are essential. A girl who is clumsy by nature would probably never be a real success in selecting chocolates and packing them in cartons and fancy boxes. Accordingly the employment department wisely submits each applicant for work to a series of simple tests, calculated to determine deftness of touch, and by so doing at least eliminate those who are never likely to make good. Among other qualifications which can readily be assessed by means of tests may be mentioned the power of observation and of memory, both essential for certain work.

It is of interest to notice that the Swedish State Railways have for some time insisted on applying methods of testing applicants for subordinate posts, such tests falling under four categories: intelligence, reaction, attention, and memory. A man whose reactions are slow and unreliable would never make good as a signalman or engine driver, and would not be considered for such a post. Tests and jobs are so tabulated that it is comparatively easy to sort out personnel to work best suited to the individual.

Dr. C. S. Myers, a well known industrial psychologist, has wisely asserted that tests can prove invaluable in the role of servant, but they must never be allowed to assume the position of master. They must always be interpreted in the light of all other known conditions, certain of which might even go so far as to discount the value of some of the tests themselves.

However, apprising them at their lowest level, I am sure carefully conceived tests can legitimately claim to be invaluable in eliminating the entirely unsuitable element, thus saving much trouble to employer and employed. Those who have the power of observation coupled with the opportunity of going round works engaged on mass production, or on the assembly of components, cannot fail to appreciate the difference between workers engaged on the same operation, and to come to the conclusion that many might be profitably employed on other work. If a casual observer can thus take stock of the position, it does not seem too much to suggest that the employment department of our modern engineering works try out the value of psychological selection, and the reduction in labour turn over should be a measure of their success. The form that the test should take must be decided by the nature of the work.

We might even go a stage further and consider the question of staff appointments, in which complaints as to nepotism are sometimes raised. In Government Departments this evil has been met to a large extent by duly accredited promotion boards, but even here, in the absence of specific tests, it is possible for a certain amount of "lobbying" to take place *sub rosa*, with members of the board "squared" in advance. It is not for a moment suggested that this perversion of justice is frequent, but it is most desirable to remove all risks.

While I should be the last to dispute the fact that "the adaptability of mankind if it be caught young is enormous," I venture to assert that in days of emergency the time of training must be reduced to the minimum.

GEORGE W. TRIPP,
F.C.G.I., M. Inst. C.E.

May 4th, 1940.

The Demolition of the "Mauretania"*

By M. WILKINSON, B.Sc.

Before describing the demolition of the "Mauretania" in detail, it is proposed to give some description of the salient points of shipbreaking so that these can be related to the special problems involved in breaking up the "Mauretania."

Ship Estimating

The first, and one of the major problems that faces the shipbreakers, is to estimate as accurately as possible the outturn weight expected from the vessel he is about to purchase. Compared to other industries, shipbreaking establishments handle large tonnages with comparatively few personnel; the shipbreaker, therefore, has not at his command a large staff of trained technical estimators. In the early days the estimation of outturn weights was largely a matter of rule-of-thumb, but latterly it has become more standardised. Owing to the competitive nature of shipbreaking, the financial margins are exceedingly small, and accurate estimating is essential. Even when using improved methods, estimating is still to a large extent a combination of experience and intelligent guessing.

Some years ago the author made an investigation to see if it were possible to standardise estimating and to bring this more under the heading of intelligence and less under guessing. After taking out a considerable amount of data, it was found that the broad outline of the main constituents of a ship's weight, as broken up, could be obtained from a series of coefficients. To begin with, these coefficients had no affinity to each other, and when graphed would not fall into any reasonable curve or straight line. As more vessels were broken up and data obtained from them, coefficients were found to fall into groups. These groups could be classified according to the size of the ship, its trade and its general construction, with modifications for age and country of origin. Even at the best the coefficient system becomes empirical, and has the disadvantage of empirical formulæ, so that results very often do not bear any known relationship to the quantities used in arriving at them. As an instance of this, it may be noted that in the ordinary three-island cargo ship the outturn weight for wood corresponded reasonably accurately with the heating surface of the boilers, in square feet, divided by 100. It was found that with the coefficient system individual estimates might err by fully as much as 10 per cent., but that on a year's working the error did not exceed ±3 per cent.

Particulars Required for Estimating.

Name :	
Builder :	Date :
Length (B.P.) :	Breadth(mld). Depth (mld).
Tonnages :	
Gross :	Under Deck. Net.
Cubic No.:	Tonnage Coeff.:
Outturn Wt. Total :	C_B
Steel Wt. (Heavy Scrap):	C_S
Total Steel and Iron Wt.:	C_{TS}
Wood :	
N.H.P.:	N.F./N.H.P.:
△/Under Dk.:	△/Net.:
Steel/△:	
Total S. and I./△:	
Boilers No.:	Type and Size :
Propellers No.:	Material :

The table shows the particulars which were set down for each vessel when estimating with coefficients. For purposes of estimating, coefficients were averaged from vessels falling into corresponding groups as previously mentioned. After the vessel was broken up, the actual outturn weights were put against headings in the estimate sheet and the coefficients compared and filed under the classification of the ship for future estimates. The main endeavour of the system was to try and obtain a reasonably accurate estimate of a vessel, using little more than the information available in Lloyd's Register. The inspection of the vessel could then be reduced to a quick survey to see in what particulars the vessel varied from her class, and how the coefficients should be modified.

It may seem strange that the foregoing is necessary, and that full information regarding the vessel for demolition is not available from the owners. In practice, however, it is found that, with the exception of large vessels, the owners have, by the time the ship is ready for breaking up, retained very little information useful to the breaker. The owner has throughout the history of the ship worked on a figure of gross tonnage which is the measurement of the capacity of his vessel that he can sell for freight purposes. The gross tonnage, however, can vary tremendously even according to certain openings in the vessel being closed or open, and bears no stated relation to displacement or outturn weight. In most cases, therefore, it is necessary for the shipbreaker to estimate for a vessel on the minimum data.

Referring to the table, length, breadth and depth are obtained from Lloyd's Register, and are respectively the length between perpendiculars, the moulded breadth and moulded depth. In some cases the moulded depth is not shown in Lloyd's Register, then it is necessary to make an adjustment to the depth shown to allow for the double bottoms or floors of the vessel. The tonnage figures are obtained from Lloyd's Register. The cubic number consists of the length B.P., breadth (mld.) and depth (mld.) multiplied together and divided by 100. The cubic number multiplied by C_B or cubic coefficient gives the total outturn weight of the ship. C_S gives the outturn weight of heavy scrap steel, and C_{TS} gives the outturn weight of all the ferrous material in the ship, including light steel, cast-iron, and sundry iron and steels. The figure for wood is obtained in most cases without a coefficient by reference to previous ships.

N.H.P. stands for nominal horse-power which, in most cases, is obtainable from Lloyd's Register. In the case of the ordinary merchant vessel, the non-ferrous material bears a distinct relation to the N.H.P., and can be expressed by a coefficient. The non-ferrous coefficient is much more open to modification than the other coefficients, due to differing standards of different owners and builders. During inspection of a ship particular care must be paid to assessing the non-ferrous coefficient. The amount of non-ferrous arising in an ordinary ship is small compared to the total tonnage, but as the values are high greater accuracy is necessary.

The tonnage coefficient, which consists of gross tons divided by cubic number, and similarly displacement divided by under-deck tonnage, and displacement divided by net tonnage, are listed for comparative purposes and in order to give an additional cross-check on the estimate. So also there is steel divided by displacement and total ferrous divided by displacement. These two coefficients show quite steady figures, particularly in ships of the same class. △ is the symbol for displacement and in the estimate refers each time to the shipbreaker's displacement and equals the outturn weight total figure.

As an indication of the coefficients arrived at, C_S ranged from 0·329 in a Japanese origin cargo steamer built during the last war to 0·42 in a high class British built merchant vessel. Similarly C_{TS} ranged from 0·394 to 0·48. Regular passenger liners, including the "Mauretania," have a C_{TS} in the region of 0·55. The large variation between the coefficients 0·329 and 0·42 for cargo vessels has to be divided up according to class and trade of vessel.

Breaking-up Operations

The main alternatives open to a shipbreaker are :—

(1) To keep his vessel afloat and break up from the top downwards, deck by deck, taking out the engines where possible, until the stage is reached where the ship is light enough to go to a beach or tidal yard which dries out at low water. At the tidal yard the breaker can complete the demolition by cutting through the bottom, dividing it up into sections. The point at which the hull is transferred to the tidal yard depends on the draught obtainable, and also on the remaining strength left in the hull.

(2) To place the ship straight away on a suitable tidal beach, cutting the vessel down, and pulling it further up the beach, alternately, until completely demolished.

(3) Breaking up in a dry dock, feasible only when a dock is available for little cost and the necessary time, or special considerations rule, such as the demolition of the inverted hulls of the ex-German battleships salved from Scapa Flow.

The first operation on arrival of the vessel is immediately to get rid of all furniture, fittings, wood decks, residual oil fuel, and other combustible material. The ship is then cut into sections as large as the available cranage will lift ashore. The burners on the shore then reduce the large sections to market size.

In recent years the demands of the steel companies have grown more and more specific, and whereas in 1918 there were very few grades or classes of scrap, nowadays the different classes of scrap are subdivided to a considerable extent. The changed requirements of the steel maker are due to a closer analysis by him of the steel scrap fed into the furnace. This demand has been met by the shipbreaker, but has involved much extra handling and, of necessity, a grading of prices.

The main grades of scrap consist of :—

Heavy steel scrap, which is cut approximately 6ft. by 2ft., with a maximum projection of 8in. The projection refers to angles, such as frames and girders attached to plain plate. This size varies a few inches in different districts and with different steel makers, the minimum thickness of material being 0·25in.

Light scrap is under 0·25in. thick, and there are various grades down to the very lightest material, which is frequently sent to the steel makers in bundles, having been first hydraulically compressed and baled.

Anchors and cables form a separate class of scrap, and in some cases are re-usable after re-conditioning and re-testing.

Cast iron has to be balled, or otherwise broken down to sizes ranging from one hundredweight downwards according to the demands of the trade.

Cast steel has to be cut down to manageable sizes for the steel maker's charging box.

Shafts and rounds form a special classification of scrap, and in many cases are re-usable, being forged down in other industries.

Boiler tubes from water tube boilers, if in sound condition, can be re-drawn to smaller bores, such as light tubing for bicycles, &c. Tubes from "Scotch" boilers in first-class condition are re-usable but rarely arise.

Timber is classified into various grades from best re-usable timber down to firewood.

Rope and canvas finds a market.

Asbestos lagging from boilers also has a specialised market.

Insulation from refrigerated spaces, such as granulated cork, silicate of cotton and magnesia, if clean and dry, is re-saleable.

The non-ferrous arising from a ship has even more classifications and grades than the rest of the material, the main headings for non-ferrous being :—

Gunmetal, graded and/or analysed; brass; condenser tubes; condenser tube plates; white metal; copper, numerous grades; pipe flanges; manganese bronze; spelter; lead; turbine blading; electric cable; aluminium.

It will be seen from the above that the complete demolition of a large vessel requires expert classification of the material arising therefrom, and also expert marketing for it. It may be said that practically nothing of a ship is wasted, except concrete filling, which comes from the double bottoms and other spaces, and a certain amount of rubbish, such as broken tiling, composition decks, &c.

What was once a vessel is to the shipbreaker his raw material, which he, in turn, passes as a finished product to other industries to become, in turn, their raw material.

Estimating for the "Mauretania" did not follow exactly the lines indicated under the coefficient system, as the owners were able to place at the breaker's disposal a great amount of useful data, the most useful figures being a displacement scale and machinery particulars. The displacement scale showed a light displacement of 30,800 tons on a light draught of 28ft. 1in. This is a condition with water in the boilers but no fuel, stores, or other water aboard. Deducting, say, 1400 tons for boiler water, this gives 29,400 tons. The coefficient system, however, was used to cross-check figures obtained from the displacement scale as, in practice, it is found that a builder's light displacement is rarely attained in a shipbreaker's outturn weight. After comparing with the nearest large liners broken up, it was estimated that, allowing for 7 per cent. wastage and irrecoverable rubbish, the outturn weight would be in the region of 27,300 tons. The actual outturn weight of the vessel when completed was 25,000 tons, plus an unweighed amount of furniture and fittings removed after the auction sale. A calculation of the figure was made by the change in draught during removal and reference to the tons per inch immersion scale. The result was approximately 1000 tons. This gives a net outturn weight of 26,000 tons or an overestimation of about 4½ per cent. This serves to emphasise the difficulty of estimating for such a large vessel when it is the first of a class undertaken, in spite of access to the builder's figures. The 7 per cent. allowance and the error consista of corrosion, concrete, years of accumulated dirt, paint, and unsaleable material that was not weighed out of the ship.

The subdivision of the outturn weight showed total ferrous material 22,500 tons outturn as against 23,980 tons estimated—error 6 per cent. This was balanced in value by an underestimate of non-ferrous of approximately 5 per cent. The non-ferrous in the vessel was of high quality and much heavier than in an ordinary ship of the same class, as large tonnages of gunmetal and copper were found.

It was decided, therefore, to dock the "Mauretania," at Rosyth, not from any change in shipbreaking procedure, but to simplify mooring the vessel. She was not put on the keel-blocks, the water was kept in the dock, and she was kept afloat. The cranage facilities were exceptionally good in this dock, there being one 15-ton and one 30-ton travelling dockside crane.

The general system of breaking up was to commence sweeping the top deck clear, and then to continue sweeping each deck clear until the upper deck was reached. At this stage it was necessary to proceed with great caution so as not to strain the vessel.

The funnels were felled much in the same manner as felling a tree. The oxy-acetylene torch was used to cut round the base, leaving only one or two supports holding the funnel. These were then cut in such a manner as to make the funnel fall along the centre line of the ship. It is worth noting that in falling the funnels collapsed with their own weight on striking the deck. The funnels proved an excellent example of one of the shipbreaker's chief difficulties, *i.e.*, paint, particularly lead paint and red lead. The paint thickness on the "Mauretania" funnels was ⅜in., and a cross-section of the paint under a magnifying glass showed successive layers of paint and, to an extent, gave the history of the ship, the layers of paint being akin to the rings of a tree. It was quite possible to distinguish the war years as the paint showed the signs of camouflage.

When cutting scrap steel, a burner has to clear away, by chipping, the paint in the way of his cut. However carefully this is done, when the torch is put through the steel, the surrounding paint and the

* Manchester Association of Engineers, March 15th, 1940. Abridged.

paint on the back of the plate or angle burns. The lead vaporises, and the operator tends to breathe in the lead fumes, and becomes liable to lead poisoning. Weather conditions share in the incidence of lead poisoning. A close moist windless day makes the lead fumes hang in confined spaces and exposes operators to increased inhalation as against dry windy days. Very careful medical inspection at regular periods helps to keep down cases of lead poisoning, but where a man shows susceptibility it is necessary to transfer him to other work free from lead paint. Masks are found to minimise lead poisoning, and the drinking of milk also helps. Masks, as designed up to the present, are uncomfortable to wear and hinder progress. A really effective light mask which does not restrict vision or impede breathing, has yet to be offered to the industry. In the case of the "Mauretania," the burners were given cocoa made with milk daily, and few cases of lead poisoning were encountered. These cases were very mild and were cured in their early stages.

In a passenger ship of the "Mauretania" type there are innumerable trunks and ventilating shafts running from top to bottom through the decks. When oxy-cutting operations are in progress special care has to be taken with these, and it is necessary to trace out each trunk or shaft in the vicinity of the cutting in case sparks are carried down them and set fire to some lower compartment or fall into oil fuel bunkers. In the case of the "Mauretania" this necessitated a systematic search and a constant watch by a fire party. In some cases it is impossible to trace the run of a trunk, and it was found effective to plug the trunk with a bag containing wet asbestos from the scrap asbestos coverings in the engine room.

The turbines were dismantled by removing the top halves and then cutting through the rotor and dividing it into convenient pieces to handle. This entailed some very heavy cutting of the larger diameters of the rotor shafts. The cuts had to be made with rotor in position and between the rows of turbine blading. The turbine blading was later driven out of the grooves of the rotor with pneumatic chisels. In some ships the blading is wired together with steel wire, and this has to be cut out in order to separate the turbine blading, which is usually of phosphor bronze in older ships. This is a laborious proceeding, but is justified by the extra value of the phosphor bronze.

After the light superstructure had been swept off, it was necessary to attack, simultaneously, both the engine room and boiler room, as well as clearing the decks. If this were not done, too much weight would remain in the centre of the ship and the vessel would sag, tending to break through her double bottoms.

The engine and boiler rooms in the "Mauretania" presented no undue difficulty beyond their congestion, which, however, was much the same as that of a warship. The engine room in the "Mauretania" was remarkable owing to the very high specification to which all the machinery had obviously been made, a specification not exceeded by Admiralty practice.

Whereas in the ordinary cargo vessel the minimum of non-ferrous is used, innumerable pieces of machinery, such as pumps, &c., were made mostly of non-ferrous in the "Mauretania." The expansion piece of the main steam pipe running between the boiler and engine rooms was of copper where it passed through the bulkhead, and of 75in. diameter. This gives some idea of the massive pieces of copper and non-ferrous that were found in the engine room. The ends of the main condensers were good quality gunmetal of very heavy section. Some of the piping was of exceptionally heavy copper, and the bends were examples of the skill of coppersmiths who were employed on the construction of the ship.

The stern presented some problems owing to the fineness of the ship and the large amount of weight without corresponding buoyancy. In order to get the vessel light enough to go round to the tidal yard it was necessary to cut away the stern considerably.

The stern was raised up further by flooding the fore end of the vessel and keeping the amidships part as light as possible and clear of loose water. The balanced rudder, which complete weighed 63 tons, had to have the top portion removed *in situ*. This left the bottom portion hanging on the rudder stock. The final lift of the bottom portion of the rudder was a very ticklish job, as the weight was something over 30 tons, and the crane was at a considerable outreach. The removal of the rudder allowed the stern to rise still higher, and the cast-steel stern frame and brackets for the two in-board propellers were cut up into sizeable pieces. The oxy-acetylene cutter severs cast-steel with much the same ease as rolled steel. Cast-iron is, however, a somewhat different proposition, and a specially designed tool is employed. The original weight of this frame was 104 tons. Here again very heavy cutting was required, the sections cut being between 1ft and 2ft. thick. The out-board propellers were also taken off while the vessel was in dock, and weighed approximately 16 tons each. This was accomplished when the boss came clear of the water, the propeller nut was removed and the propeller drawn off the shaft. In one case difficulty was experienced in drawing the propeller and the shaft was cut through between the boss and the stern tube.

At this stage the vessel was removed from the dock and laid alongside a quay, but still kept afloat. Breaking-up operations were continued, gradually sweeping the decks down until the ship was cut down to lower deck level at the ends and main deck level at the centre.

In this position alarming signs of flexibility of the hull became apparent. Forty-foot battens were placed on the deck, with their ends about a foot past each other. The other ends were fixed firmly to the deck. Pencil marks were then drawn across the battens which were free to move past each other. It was found that as weights were taken off the ship these pencil marks opened and closed by approximately a quarter of an inch. The battens proved a very valuable guide as to which portions of the ship to remove next, and an endeavour was made to keep the pencil marks in line, and avoid unduly straining the remaining structure. At the outset as the decks were cut away the vessel, from the side view, appeared to be cut in a series of steps, that is—as the cutting proceeded from amidships to the ends, it was stepped down a deck for about one hundred feet along, and then down again another deck, leaving a large amount of strength in the centre.

At the period when the battens were installed, it was found that the sharp angular contour of the cuts from one deck to another showed signs of cracking in the shell plates at the bottom of the angle; thereafter the cuts were swept down from one deck to another in long diagonals or curves to avoid this.

In order further to lighten the ship the bow was flooded again, and the tail shafts of the out-board propellers were drawn into the ship. The stern tubes were also cut off, and patches fitted over the openings.

The vessel was finally cut down to the lower deck, leaving all the remaining bulkheads intact, and with the engine and boiler rooms completely swept clean. At this stage she had a draught of approximately 14ft. forward and 10ft. aft.

Beaching

The tidal beach on which the ship was finally demolished was restricted for depth, and full advantage of high water spring tides had to be taken in order to run the ship up, the rise and fall at Rosyth being in the region of 18ft. at springs.

General

The "Mauretania" was broken up by using oxy-cutting blowpipes for dealing with all mild steel and cast steel, with occasional cuts through larger pieces of cast iron. Hand blowpipes, of ordinary design, using medium sized nozzles, were employed. Special blowpipes were used on comparatively few occasions, and then only for cutting through heavy parts at the stern or in the engine room.

The consumption of oxygen per ton cut varied considerably, as was to be expected when undertaking work which ranged from light deck houses to heavy shell plating, and finally heavy bottom plate encrusted with rust, mud, and oil. No accurate figure of oxygen consumption was kept, but from tests taken from time to time, the average lay in the region of 350 cubic feet per ton of material cut out of the ship and cut ready for the market.

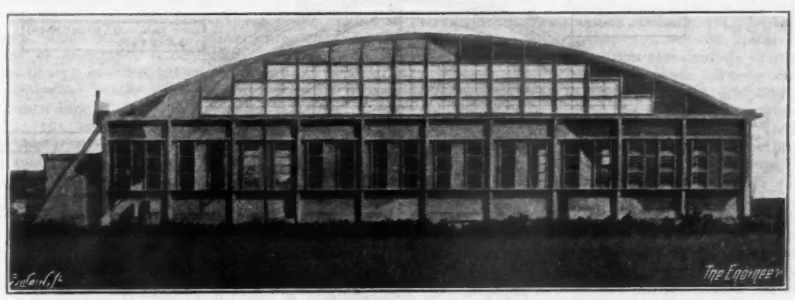
The output per man on a blowpipe also varies considerably according to where the man is working, material he is cutting, and the man's capabilities. A first-class operator working on good clean shell plating or boiler plating has no difficulty in turning out 6 to 8 tons of material per day, cutting lifts that have already been taken out of the ship, and reducing them to market size.

The overall output for the total number of burners employed and the total steel in the ship, inclusive of cutting first to crane size and then to market size lies more in the region of 2½ to 3 tons a day. These figures were only obtained by giving the burners every facility, and oxygen and fuel gases were piped all over the ship; no cylinders whatever were used. The oxygen was led up the side of the dock in high pressure pipes, was then led on to the ship to a reducing valve and distribution box, and the burners were coupled on their individual lines of flexible hose to the distribution box. The pressure in general for the main part of the work was 120lb. to 140 lb. per square inch at the reducing valve. This may appear high, but there was a considerable drop in pressure from the reducing valve to the cutting nozzle, due to long lengths of small bore flexible pipe being trailed through the ship. The usual pressure actually delivered to the cutting nozzle was in the region of 40 lb. to 50 lb. per square inch. Again, this may appear high, but the general endeavour throughout the demolition operations was to keep up the speed of output. It was found that though these high pressures have disadvantages, they enable the burners to cut through dirty material and keep up their output rates. The "Mauretania" was broken up to a time-table. By this is meant that before her arrival at the breaker's yard a proposed time-table was forecast. The advantage of this lay in assembling personnel, disposing of the material by contract, and fitting in with operations running concurrently on other vessels being broken up. The vessel arrived at Rosyth in the first week of July, 1935, the last lift came ashore at the beach yard in August, 1936; a total of 13 months. This is equivalent to an average output or rate of demolition of 500 tons per week, the maximum figure at the heaviest part of the hull being over 700 tons per week.

Aeroplane Hangar

A LARGE reinforced concrete hangar has been recently built in the south of France. The hangar is 265ft. long by 163ft. wide. Its height is 39ft. 4in. The structure is flanked on the north side by an office annexe 158ft. long by 22ft. wide and 33ft. high. The hangar is covered by a concrete roof supported on a series of trusses, spanning the whole distance without any intermediate support. On the south side provision is made to take the track for the sliding doors which form the fourth enclosing side of the hangar.

The main feature of the structure consists of seven roof trusses. These trusses are of the lattice type, having a span of 265ft. 4in. and a rise of 32ft. 10in. The upper and lower booms are interconnected by means of V-shaped inclined members. The upper booms have a catenary outline, while the lower booms which act as ties are horizontal. The booms are generally 30in. high by 12in. wide. A minimum thickness of 3in. was adopted for the roof slab. As regards the vault, it has no ribs at the extrados, thus producing a smooth surface on the outside. The concrete slab is covered with three-ply Ruberoid roofing, laid on a coat of bitumen.



REINFORCED CONCRETE AEROPLANE HANGAR

The pillars of the south side are fitted with two hinges, one set being below the anchorage blocks of the truss ties, while the others are placed slightly above the ground. On the north side, the pillars are rigidly connected to the footings and to the roof slab. The north side is also provided with two concrete rakers, which act as wind-bracing members. To resist the wind stresses, there is horizontal lattice girder bracing, the chords of which are formed by the ties of the two extreme trusses.

In the other direction, there is a series of concrete beams, spaced at 53ft. centres, carrying the crane tracks (monorails), which act as wind-bracing members. The foundations are on firm soil, composed of clay and marl, which being of good quality required no special precautions, since the unit pressure does not exceed 4½ tons per square foot, taking into account the stress due to wind.

The hangar is fitted with sliding metal doors. The structure was erected within eight months. A special working programme was followed by the contractors and steel tubular scaffolding was used to support the shuttering. The work was executed in the following manner:—When a bay was concreted (including its rear truss and the upper boom of its front truss), the diagonal members and the ties were fitted with reinforcement bars, the tie rods being rigidly anchored in the fixing blocks. These ties were reinforced with continuous bars $\frac{9}{16}$in. diameter, without intermediate laps or hooks. Before concreting each tie it was submitted to the tension due to the load caused by the weight of the top boom and the roof. Then the inclined members were concreted. When the concrete had set, the centring was dismantled and the same operation was then repeated for the following bay. The results of loading demonstrated that the roof structure was of great rigidity, the maximum deflection measured not exceeding $\frac{1}{800}$ of the span in the most unfavourable circumstances.

The contract was carried out by the Entreprises Boussiron, of Paris, under the direction of Mr. Magrou, engineer to the Société Nationale de Constructions Aeronautiques du Sud-Est.

Long Distance Broadcasting*

By SIR NOEL ASHBRIDGE, B.Sc., M.I.E.E.†

(*Continued from page 416, May 3rd*)

LET us now turn to the practical application of these main principles. As far back as 1927 there were one or two broadcasting stations working on short waves, somewhat irregularly, which were nevertheless attracting a good deal of attention, more particularly on the part of those interested in the technical side of reception rather than in the programme material broadcast. Although reception of a kind was not particularly difficult to achieve, it was thought by many that owing to the distortion which was, in the circumstances then existing, frequently severe, such a service had little value from the point of view of a serious broadcasting service. However, the B.B.C. decided to make some prolonged tests in order to explore the reaction of people in various parts of the Empire who possessed short-wave receivers. For this purpose a single transmitter was made available which radiated on the single wavelength of 24 m. (afterwards changed to 25·53 m.), using a non-directional Franklin vertical type of aerial, supported on two 480ft. steel masts. From what has been said already it will be obvious that a single transmitter working in this way would not be well received simultaneously all over the world, since the wavelength could not be suitable at any one time for the different conditions of season and sunlight. Nevertheless this transmitter was heard for some period of the day and year in almost every part of the Empire and a great deal of information was obtained. However, it was found that still most of the interest came from those who were concerned with technical experiments in reception, although when well-known speakers were broadcast there was considerable enthusiasm from those areas where conditions permitted of good reception and complaints from those where the reverse was the case. There was also an insistent demand for regular news bulletins at convenient times.

After a long period of experiment it was decided early in 1932 to erect a station on rather more elaborate lines, which would allow listeners overseas to receive a daily programme during reasonable hours in the evening. There was perhaps still some doubt as to the financial justification for a service on a large scale and for this reason the minimum amount of plant was installed consistent with the possibility of reception under the conditions just mentioned.

It will be realised that in order to arrange for reception during the evening in all parts of the Empire, it is necessary to transmit almost continuously throughout the 24 hours. Moreover, if it is agreed that reception need only be provided during the evening, the areas to be served can be mapped out in zones and the programme given to each in turn. It is fortunate that a division to take account of local time fits in well with the necessity of using a number of directional aerials to increase the strength of reception to the practical maximum.

Having decided on directional aerials and the bearings on which they are to be erected, it becomes necessary to consider how wide the beam should be, and this, of course, depends on the extent and geographical position of the territory to be covered by any particular aerial. The problem is somewhat analagous to some elaborate scientific system of floodlighting, where the direction of the beams of of light and their width have to be studied in relation to the areas to be covered by light. The accompanying engraving shows a map of the world plotted on what is known as Pletts zenithal azimuthal projection. This shows the true direction of any point in the world as viewed from London and indicates directly the width of beam necessary to cover any particular area. It also shows that the extreme limits of the whole Empire actually subtend an angle of approximately 320 deg. at Daventry. Clearly, narrow beams could be used serving restricted areas with strong field strength or wide beams covering larger areas less effectively. The choice between these two extremes must, of course, be a compromise, taking into account the number of transmitters which can be made available and the length of time for which it is desired to give a programme to each zone.

The 1932 station at Daventry had two transmitters of about 10/15 kW, and the aerial arrays consisted of curtains of vertical dipoles with reflectors erected on steel tubular masts some 80ft. high. There were five main arrays directed on Australia, India, South Africa, West Africa, and Canada respectively. The width of beam varied with the direction of transmission and, of course, provision was made for the necessary changes of wavelength in each case. This, the first short wave broadcasting station to be erected in this country, was opened for service on December 19th, 1932.

The results were naturally far better than from the single wavelength experimental transmitter; in fact the success of the station was undoubted and it resulted in a great deal of overseas correspondence and many suggestions for improvements. Moreover, its success was not merely a technical one, and the programme value—even taking into account the irregularity of really good reception—was generally admitted. Nevertheless it was obvious that its value would be very much greater if stronger, clearer reception was possible and a serious study of how this might be achieved was begun early in 1933.

There were two methods which had to be considered. First the provision of more efficient aerials from the point of view of the necessary characteristics to give the most advantageous reflection from the ionosphere, secondly, the possibility of using considerably higher power transmitters; although the transmitters in use were the most powerful commercially available in this country at that time. There are two general points concerning these alternatives which are important. The efficiency of aerial design is chiefly concerned with confining the beam of radiation not only in a horizontal plane but also in the vertical plane, and projecting it at the correct angle so that reflection from the ionised layer shall take place with the minimum of absorption. Now this angle of what might be called vertical directivity must naturally be chosen to suit average conditions and cannot be the best for all conditions likely to occur. The gain obtainable by ensuring correct conditions in this respect is extremely important and, in fact, vital; on the other hand, the gain due to an increase of transmitter power remains good for all conditions, whether average or otherwise.

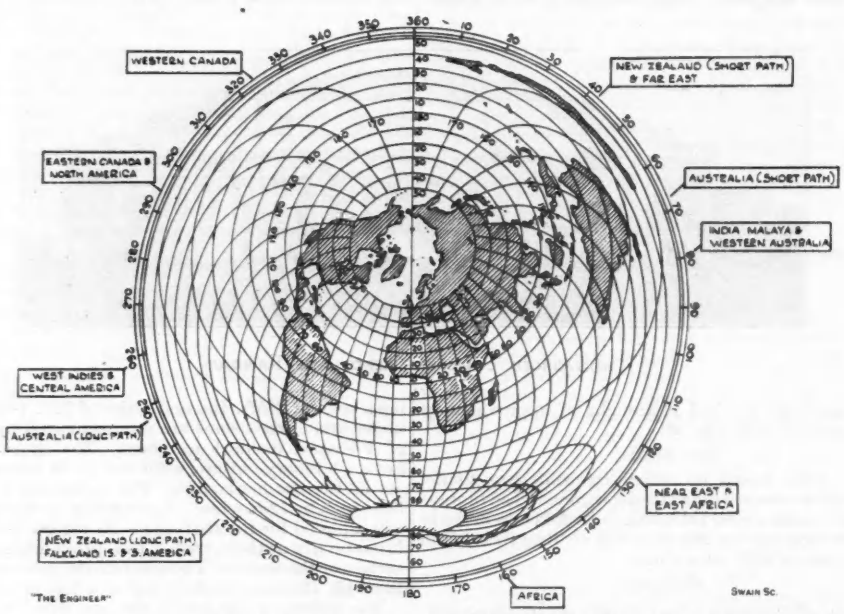
Gradually the original system of vertical dipoles was replaced by horizontal aerials of this type, and a larger number of arrays became necessary since in general the width of beam was less. Several were arranged with reversible reflectors so that they could be used for transmitting in either of two opposite directions. In certain cases, however, the arrays are operated without reflectors, so that the same transmitter is serving two opposite directions simultaneously, giving, say, a news bulletin at night to one part of the world and in the morning to another. There is, however, a peculiarity which may give trouble when this method is used. This arises from the fact that ionospheric conditions may be such in relation to the wavelength that a transmission may travel to the same region simultaneously by two routes, going both ways round the world. If this happens there will be an interference effect between the waves travelling by each route, giving a kind of echo effect due to the time difference between the two transmissions.

With an aerial of the standard type already described it is possible to distort the direction of the beam in the horizontal plane, so that the direction of maximum projection is not, as normally, exactly at right angles to the plane of the aerial curtain. This can only be done efficiently to a limited extent, which is about 12 deg., but it has been adopted at Daventry for certain arrays to reduce the number of masts as far as possible.

Before the war there were about 30 separate aerial arrays at Daventry, occupying a site area of about 160 acres. To support these aerials there were in all 12 masts, varying from 500ft. to 150ft., the taller masts being used for the longer wavelengths and vice versa. It will be understood that a single short-wave curtain of this type can only cover a very narrow band of wavelengths and it is for this reason that a large number of aerials is necessary. The power is conveyed from the transmitters to the aerials by overhead twin open-wire feeders. Associated with the transmitters and feeder lines there is a switching frame giving selection as between transmitters and aerials.

In 1936 it was decided to instal additional transmitters of considerably higher power than was commercially available at the time, and two prominent manufacturers in this country were asked to develop special designs capable of an output varying between 50 kW and 100 kW. The higher power is obtainable on the longer wavelengths and the lower on the shorter wavelengths.

From the engineering point of view the development has taken place in the astonishingly short period of about five years. It has been based on many years' research by some of the world's most eminent scientists, followed by much patient work by engineers, and one cannot conclude without a word of regret as to the abuse to which it is now subjected in certain countries. For a listener in any country—or at sea—to be able to hear objective news and the best speakers, from all the great centres of the world, is an advance the value of which few people will challenge. That these stations have been used for other less worthy and even contemptible purposes is not the fault of those who have put so much labour into their creation. Let us hope that this reproach will soon have been removed.


WESTERN CANADA
NEW ZEALAND (SHORT PATH) & FAR EAST
EASTERN CANADA & NORTH AMERICA
AUSTRALIA (SHORT PATH)
INDIA MALAYA & WESTERN AUSTRALIA
WEST INDIES & CENTRAL AMERICA
AUSTRALIA (LONG PATH)
NEAR EAST & EAST AFRICA
NEW ZEALAND (LONG PATH) FALKLAND IS. & S. AMERICA
AFRICA
"THE ENGINEER"
SWAIN SC.

MAP OF THE WORLD ON PLETTS ZENITHAL AZIMUTHAL PROJECTION

* The Royal Institute of Great Britain. Abridged Paper. January 26th, 1940.

† Controller of Engineering, B.B.C.

The Esla Viaduct

THE erection of the Esla Viaduct (Spain), which we described in our issue of August 5th, 1938, is now rapidly approaching completion. This reinforced concrete arched bridge is situated on the line between Zamorra and Corunna over the river Esla. The structure is designed to carry a double track of Spanish gauge with a loading of 25 tons per foot run on each rail. The central arch has a span of 672ft., but owing to the fact that the line of the abutments is a continuation of the line of the arch, the span upon which calculations have been based is of 562ft. only. The arch is to be formed in a three-cell box section and will have a width of 29ft. 6in. at the springings and 26ft. at the crown, the corresponding thicknesses being 18ft. and 14ft. 10in.

Timber centring to carry the concrete for the arch was in place early in 1938. Owing to the Spanish civil war, the progress of works was extremely slow and the centring suffered considerable damage and deformation from wind and rain. After the end of the civil war it was decided to replace the timber centring by a new centring composed of steel lattice trusses. The erection of this latter is now nearly completed. The concreting of the arch will be performed this month, and the superstructure is expected to be completed by June. The viaduct, which bears the name "Viaducto de la Victoria," will be opened by the authorities in July, 1940.

The viaduct is being built under the direction of Professor Alfonso Pena, Minister of Public Works, and Sr. Cesar Villalba, Chief Engineer of the Spanish Highway Board. The Esla viaduct will be, when completed, the longest reinforced concrete arch in the world, exceeding in length the bridges of Plougastel (France) and Tranebergsund (Sweden). The cost of the viaduct is estimated at 6,464,996 pesetas (about £165,000).

BALTIC-BLACK SEA WATERWAY.—Reports from the U.S.S.R. state that vessels have left Pinsk for Brest-Litovsk on a trial trip on the newly enlarged Dneiper–Bug Canal. This canal forms part of a 900 miles waterway from the Black Sea to the Baltic at Danzig which will shortly be in use.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.

The New Steel Distribution Scheme

The Iron and Steel Control Department of the Ministry of Supply has issued an explanation of certain features of the new scheme for steel distribution, and in doing so expresses appreciation of the support which has been given the scheme by the industry and consumers. It is pointed out that the scheme does not apply to iron or iron products. Attention is drawn to the importance of obtaining and reporting symbols, reference and period numbers by May 31st for orders placed prior to April 8th this year. There has been some delay on the part of consumers in obtaining their symbols, and it should be realised that even if orders were already placed before April 8th, unless the symbol is reported by May 31st, they will not obtain delivery of their steel. Symbols and period numbers are required with all orders involving the supply of steel except for finished steel supplies coming under the following categories :—(*a*) all home civil requirements except where specifically included under another Department—B.T. (1); (*b*) miscellaneous agricultural requirements other than agricultural machinery and buildings—B.T. (3); (*c*) indirect exports, i.e., exports of finished goods, excluding requirements of B.E.F. and oil companies and French Government requirements—B.T. (4); (*d*) direct exports, i.e. exports of finished steel as listed in Appendix A, excluding requirements of B.E.F., India, and oil companies and French Government requirements—B.T. (5); (*e*) steel for conversion into other steel products set out in Appendix A. In cases (*a*) to (*d*) licences are required and for recording purposes the appropriate symbol and the period number will be inserted on the licence by the Control. Except where licences are to be obtained from the Iron and Steel Control the main contractor must obtain a written authority from the Department concerned to use and pass on their symbol. In the case of public undertakings to which a tonnage of steel is allotted by a Department, such as a Port Authority, the undertaking should obtain and pass on the symbol required under the scheme. The replacement of steel used from a manufacturer's stock is dealt with, in cases where there is a comparatively small tonnage covering a large variety of orders, by the customer estimating closely and supplying to the seller the tonnage under each Department and certifying that he has the necessary symbol and reference numbers for each of the orders in respect of which the replacement of steel is desired. It will not be necessary in ordering ball and roller bearings to quote any symbol. Manufacturers of these articles will obtain their finished steel from the producer by quoting the Ministry of Supply reference and period numbers. The Ministry of Supply's statement also covers directions as to when licences to buy finished steel are required. Applications for licenses should be made to the Iron and Steel Control, Steel House, Tothill Street, London, S.W.1 on the appropriate forms, but a composite application form will shortly be available. Licences are required for the purchase of finished steel to fill orders for the categories B.T. (2) to B.T. (5).

The Pig Iron Market

The situation in the pig iron market, although it has its difficulties, is, on the whole, satisfactory. There are no reports of urgent work being held up through delays in deliveries, and the Control appears to have solved the chief problems of distribution. Large tonnages are passing into consumption and the demand appears to be gradually expanding, with the result that there is not a great margin between production and consumption. There has been much discussion lately as to the effect upon the British pig iron industry of the interruption of the supplies of Swedish ore. Apparently the pig iron industry, in common with others having trade interests in Norway, is unable to ascertain the position at Narvik. It is understood that good stocks of Swedish ore are held in Great Britain, but at the same time arrangements have been made to bring in suitable ore from other producing countries. It is possible, of course, that considerable stocks may exist at the port of Narvik which later on may be available for the British industry. On the North-East Coast the production of pig iron has been speeded up, but attention has been devoted almost entirely to the production of steelmaking descriptions, and the manufacture of Cleveland foundry iron has been practically suspended for a period which began some time before the outbreak of the war. Founders on the North-East Coast are obtaining their supplies from Midland furnaces and appear to have become reconciled to the use of the latter descriptions. The Midland blast furnaces are producing at capacity, but the demand for high phosphoric iron is still weak. There has been some improvement, however, during the last week or two as an effort has been made to bring the light castings foundries which were working only three or four days a week into the war effort, and some of them are now more actively employed. The request for low phosphoric iron is maintained and consumers' requirements are probably somewhat in excess of the production. It is understood, however, that the output of this quality iron will be increased. Scottish foundries are also participating to some extent in the distribution of work by the Government, and as a consequence there is a better demand for foundry iron. Stocks exist at the furnaces, and this iron is in moderately free supply. Great activity prevails in the hematite market and practically the whole of the production passes immediately into consumption. The demand is particularly heavy from the Sheffield district. The makers, however, are so well booked that they are not anxious to accept fresh business as the prospects of increasing the production of this description appear somewhat remote. Business in basic iron is at a high level and all quantities becoming available are quickly taken up by the steelworks.

Scotland and the North

The Scottish steelworks are maintaining production at maximum capacity. A large number of consumers are engaged upon Government contracts and there is also a considerably larger tonnage of work waiting to be placed. The production of munitions has been accelerated of late and this of course has had a repercussion upon the steel industry. Already it is said that the new steel distribution plan is being strained to its utmost, but it is obvious that some time must elapse before the full benefit of the scheme can be felt. The heavy steelmakers in Scotland have sufficient work on their books to keep them employed for several months. The call for bars, joists, and sections remains insistent from the constructional engineers and the shipyards, the former industry, which has a large volume of work in hand, being assured of additional orders in the near future. In fact the programme for the erection of workshops, &c., is likely to provide an outlet for structural steel of all sizes for a long time. All the shipyards have enough work to keep them operating full time, and their steel requirements are therefore extremely heavy. The marine engineering shops are taking up large quantities and their requirements are likely to be considerable for a long period. The large number of armament contracts which have been given out call for enormous deliveries of special steels, and these are a feature of the situation. Consumers' requirements, including the boiler and tank makers, wagon builders, and locomotive makers, are putting a considerable strain upon the resources of the steelworks, which are also receiving heavy calls from other industries. All the Scottish tube works are in full production, as there is a vigorous demand for practically all descriptions of tubes. The Scottish wrought iron manufacturers have experienced a considerable change in their position since the beginning of the year. Then only a few of them were operating full time; now all the plant is occupied, some of it on the production of iron in substitution for steel as it is possible to give somewhat better delivery times for the former. In the Lancashire district one of the features of the situation is the pressure to secure supplies of special and high speed steels. The demand for colliery steel is also well maintained and there is an urgent request for arches and roofing bars. The chief demand, however, is for structural steel, bars, and plates.

The Midlands and South Wales

The great activity in the Midland iron and steel trades continues unabated. Consumers, however, are still finding it difficult to place new business since few of the works are in a position to give anything but far distant delivery. Both consumers and manufacturers are devoting their attention to working out the new steel distribution scheme. The general view is favourable to the new arrangement, but it is thought that it will be a long time before it can settle down to smooth working. A good many Government Departments have already placed all the orders they can for the first period, which ends in June. It is suggested that already a considerable amount of duplication in ordering has been prevented, but owing to the excessive demand there is a large amount of work which consumers have not yet been able to give out. The heavy steel trades continue to experience great pressure to obtain delivery and their production has been speeded up until it is now at a record level. The output of structural steel is particularly heavy and is eagerly taken up by the constructional engineers and the shipyards. Plates of all descriptions are actively sought after, but the demand is rather stronger for the thick and medium grades than for other descriptions. In the lighter branches of the trade the demand for small bars is keeping the re-rollers fully occupied and there is also a steady request for strip and small sections. To a great extent the re-rollers have now been relieved of the worries attendant upon a shortage of billets. Supplies are now reaching the works more freely as a result of the considerably increased imports. A good many of the re-rollers, however, have to catch up with arrears of deliveries which accumulated during the time when it was difficult to obtain billets and sheet bars. The sheet makers in the Midlands are fully employed and although they are experiencing a strong home demand they are able to do a certain amount of export business. The heavy steelworks in South Wales are operating at capacity, but even so production falls below the requirements of the consuming trades. The tinplate makers are urgently pressing for larger supplies of tinplate bars and complain that their activities are limited by the restricted quantities of steel they are receiving. The shipyards and ship repairers in South Wales are fully employed and are eagerly seeking supplies of plates and shipbuilding steel.

Copper and Tin

The British market for copper is unchanged, and there seems no likelihood of conditions altering, since the Control appears to be operating satisfactorily and is able to distribute supplies freely. Naturally a certain amount of caution is exercised in releasing copper for other than war purposes. For this reason consumers who require the metal for the manufacture of commercial products do not find it easy to obtain full supplies. Few plants making manufactured copper materials are engaged upon anything but war work and heavy tonnages are passing regularly into consumption. In the world market conditions have become somewhat weaker and the extension of the war to Scandinavia has had a deterrent effect upon buying from neutral countries. In the United States the domestic consumers have shown little interest in the market and buying for export has been on restricted lines. Apparently interest has been aroused abroad by reports that the British Government intends to increase its supplies, but if this becomes necessary it is thought that the Empire producers will be able to provide all that is needed. It seems possible that copper ordered for Scandinavia in America will now be resold owing to the difficulty of transport under the conditions ruling in the Baltic. . . . A rather firmer tone developed in the tin market in the latter part of last week. A certain amount of business has been done with America, but the quantities have not been large. The transactions, however, have been of a day-to-day description. Italy and Russia have also been in the market, but the latter country appears to have difficulty in covering her requirements owing to the reluctance shown by the producers to sell. The backwardation still persists owing to the tightness in spot supplies. The market, however, does not regard the position favourably and it is suggested that it is due in part to manipulation. Consumption is on a good scale. In the British market also the situation has been confused to some extent by the war in Scandinavia, since Baltic countries took an appreciable quantity of tin, and for the time being at any rate this trade has been checked. To a certain degree it may counter the effect of the International Tin Committee's cut in the export quota, which it was thought would curtail supplies and raise prices. According to the statistics published by Mr. W. H. Gartsen, the total visible supply at the end of April was 23,119 tons, compared with 22,980 tons at the end of March. The monthly supplies amounted to 12,808 tons against 15,961 tons in the previous month and the deliveries to 12,669 tons against 16,846 tons in March.

Lead and Spelter

The lead market in Great Britain seems to be in a comfortable position. So far as can be gathered, supplies are arriving regularly, and the distribution by the Control is satisfactory. A heavy tonnage is moving into consumption, but the works are apparently obtaining regular deliveries. As in other non-ferrous metals the Control keeps a watchful eye upon the amount of metal used for purposes other than war work. There does not, for instance, appear to be a sufficient quantity of metal in this country to permit the use of any important tonnage for manufacturing products for export. There was some talk a little while ago that lead should be imported from foreign sources to be used for this purpose, but nothing has been heard of the suggestion recently. In the world market the demand for the metal is irregular and complaints are heard from some countries of the difficulty of obtaining full supplies. Most of the neutral countries are being rationed under the allied contraband control. Foreign lead producers are not finding it easy to dispose of all their metal and this is particularly the case with the Mexican producers, who find the dislocation of the freight position a serious hindrance to their trade. . . . The consumption of spelter in Great Britain is proceeding at a high rate and all supplies appear to be quickly taken up. The Empire production, however, seems sufficient to meet the full requirements of the country even under the pressure of the war. The galvanisers are taking large quantities regularly and although the use of galvanised sheets for air raid shelters is now insignificant as these contracts have been practically completed, sheets are required in large tonnages for war purposes in other directions. The brassmakers also are operating at capacity and it may be assumed that the Government's requirements are likely to increase rather than the reverse as the war continues. Not only is the demand for sheets for Government purposes taking up considerable tonnages of spelter, but it is expected that galvanised sheets will figure in the export drive so that the requirements of this industry may be expected to expand. India has been a rather anxious buyer of Belgian spelter during the past week or two. In normal times Belgium supplies large tonnages to Great Britain, and under present conditions the tonnages have considerably increased. India has also bought spelter in the United States.

Non-Ferrous Metal Prices

The statement issued by the London Metal Exchange showing the average prices for tin in April indicates that, with the exception of three months' tin, quotations varied little from the March level. In the case of cash tin the average for April rose by 7*s.* 7d., the settlement price being 6*s.* 9d. higher, whilst for three months the average dropped sharply by £2 5*s.* 6d. compared with the March figure. The official maximum prices for copper, lead, and spelter fixed by the Controller of Non-Ferrous Metals are also included, and are as follows :—

STANDARD TIN ...	Cash (Mean) £252 5*s.* $1\frac{1}{4}$d.	
	3 Months (Mean) £248 7*s.* $4\frac{7}{11}$d.	
	Settlement (Mean) £252 3*s.* $10\frac{4}{11}$d.	

The following prices for copper, lead and spelter are the maximum prices fixed by the Controller of Non-Ferrous Metals :—

	£	s.	d.		
STANDARD COPPER ...	—				
Electrolytic Copper ...	62	0	0	delivered buyers' premises	
Electrolytic Wire Bars...	62	0	0	,, ,,	,,
Best Selected Copper ...	60	10	0	,, ,,	,,
Lead—Good Soft Pig ...	25	0	0	,, ,,	,,
(Foreign)					(duty paid)
Spelter—G.O.B.	25	15	0	delivered buyers' premises	
(Foreign)					(duty paid)

LORD ASHFIELD'S NEW APPOINTMENT.—The Minister of Transport has appointed the Right Hon. Lord Ashfield, the Chairman of the London Passenger Transport Board, to be a member of the Railway Executive Committee, and has accepted the resignation of Mr. Frank Pick from membership of the Committee in view of his approaching retirement from the position of Vice-Chairman of the Transport Board.

French Engineering Notes

(From our own Correspondent in Paris)

Paris Metropolitan Railway Shelters

THE work of preparing air raid shelters on the Paris Metropolitan Railway is nearing completion. It is much less ambitious than that originally proposed by the company's engineers, who drew up a plan for making full use of the 50 miles of tunnel for the purpose. As the tunnels are mostly near the road surface they would have needed protection by laying over them reinforced concrete slabs something like 6ft. thick, and, in the circumstances, it was decided to limit shelters to stations at depths offering complete safety. The engineers affirmed that, by taking into account soil resistance to penetration and shock above the tunnels, the depths for shelters could be safely reduced and the number of stations considerably increased. A primary necessity was to protect the shelters and the tunnels from gas attack. A beginning was therefore made with the equipment of two stations that would serve as models for others. The stations selected were the one under the Place des Fêtes at Belleville, where the tunnel is driven through hard clay at a depth of 68ft., and the other at Maison-Blanche, at a depth of 26ft. in the limestone formation of the Buttes-aux-Cailles. The principle adopted of isolating shelters from gas is the raising of the air pressure inside the stations above that outside. From the station entrance down to the platforms there are a series of air-tight partitions with doors that open out both ways and close hermetically. They constitute a number of chambers or air locks ranging from three to six. The installation provides for a maximum air pressure inside the station of 110 mm., which is reduced to 60 mm. in the station and lowered by stages in the air locks or chambers down to 20 mm. in the first chamber, where it is supposed that this pressure would rapidly eliminate any gas contaminated air entering with people who pass within. The other chambers with increasing pressures would offer a complete obstacle to an infiltration of gas. Air is drawn from outside by an electrically driven fan and passes through a battery of five rectangular filters, nearly 6ft. high, mounted on wheels for easy replacement. The filtering capacity of a battery is from 8000 to 10,000 cubic metres an hour. There is a hand-controlled valve on the outlet pipe of each filter, and adjustable valves on distributing pipes in the station and air locks. The entire installation is controlled from a switchboard. At the same time, the current for traction is cut out, and trains remain in the tunnel and stations where they happen to be until the "all-clear" signal is given. The working of this general arrangement cannot be made clear without a fuller detailed description, which is debarred from publication by national defence restrictions. Nor can it be said how many stations are being equipped in this way as shelters, but their number appears to be fairly large and includes at least all the more important stations and many others that are regarded as offering adequate safety. While there seems to be some exaggeration in statements made of the number of persons who may be accommodated in a time of real danger, there is no doubt that the Metropolitan Railway will render a valuable service should necessity arise.

Industrial Development

Annual reports of iron, steel, and engineering companies for 1939, ending August 31st, all tell the same story of increased activity and heavier production, improvement in works equipment and, in quite a number of cases, large augmentations of capital. Already in 1938 the tide had begun to turn and later swelled into a flood with orders given out for work on national defence. Since the beginning of the war works have been extended and new plants put down, sometimes with State assistance, and the engineering production and capital investment have increased considerably. After the war, the industry will be in a far more important position than formerly, now that everyone sees that the national existence depends upon it. There will be many problems to solve, which is a reason why France and Great Britain should seek a solution while there is yet time. This accelerated expansion of industrial production since the outbreak of war has been effected under complete State control which limits profits on national defence work to 4 per cent., and while manufacturers accept this restriction they are still somewhat uneasy as to what will happen to them after the war. They have not forgotten the disastrous experience of the former Socialist Government with its programme of State control and nationalisation. The present Government affirms that manufacturers will resume their full liberty and initiative, and there is every reason to believe that industry will settle down again under normal conditions, with the State aiding instead of controlling it, particularly now that the industrial organisation is sufficiently powerful to look after its own interests. There always has been a strong national feeling against the State interfering with private initiative. The experience of three years ago made it perfectly clear that industry cannot be carried on without capital, and no capital is forthcoming when industry is controlled in accordance with Socialist principles. Another phase of industrial evolution is the decentralisation of works and factories which is rendered necessary on a fairly large scale by war conditions and is, at the same time, identified with the idea of social progress that has made so much headway of recent years. Many works have been moved away from industrial centres, most of them from the dangerous zone behind the western front, and others have gone to safer areas within range of raw material supplies and transport facilities. Workers and their families and technical staffs have to be conveyed to these areas, where housing has to be provided for them, and the cost of building houses would be a heavy burden on employers if they were not relieved of it to a large extent by State loans and other advantages. Houses for workers can only be built in accordance with plans approved by the State. It is hardly possible to ascertain at present the extent of this decentralisation movement, but it will be interesting to know its importance after the war, as well as its precise character and how far it is likely to develop in the light of present experience.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

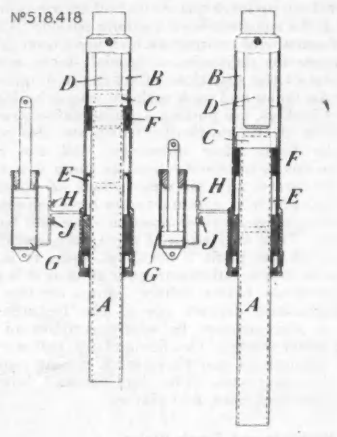
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

AERONAUTICS

518,418. August 24th, 1938.—AIRCRAFT LANDING GEAR, Vereinigte Deutsche Metallwerke Aktiengesellschaft, Hessestrasse, Heddernheim, Frankfurt-on-the-Main, Germany, Fritz Faudi, Falkenstein-on-the-Taunus, near Frankfurt-on-the-Main, Germany, and Eduard Toennis, Am Forum 22, Frankfurt-on-the-Main, Germany.

This invention relates to means for utilising the potential energy of the landing gear when stressed by the stationary weight of the aircraft. The landing gear strut consists of a hollow piston rod A movable in a cylinder B and having a piston C. The space, filled with compressed air, above the piston together with a plunger D adapted to enter the piston rod serve for the actual springing of the landing gear, while the space E formed beneath the piston is intended to take the recoil. The plunger serves as a displacement piston so that on its entry into the

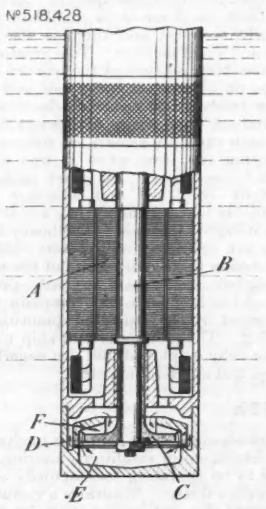


cylindrical space in the upper part of the piston rod it causes displacement of the air or other shock absorbing medium contained therein through slits or openings (not shown) in the piston. The air space is sealed at the top by a sliding packing ring F, and at the bottom by the usual stuffing box packing. When the strut is relieved of stress, so that it assumes the position shown in the right-hand view, the pressure above the piston is relieved and the air in the chamber below the piston is compressed. In this case the air chamber E acts as an energy accumulator. In order to utilise this compressed air, it is supplied to a servomotor consisting of a cylinder G. Depending on the opening of cocks H or J, the servomotor piston is actuated and performs the corresponding working movement. The operation of the inlet aperture may be controlled manually or automatically. Instead of one working cylinder a plurality of working cylinders may be used.—*February 27th*, 1940.

PUMPING AND BLOWING MACHINERY

518,428.—August 25th, 1938.—ROTARY IMMERSION PUMPS, Sulzer Frères Société Anonyme, Winterthur, Switzerland.

In the construction illustrated the rotary immersion pump is driven by an electric motor A which is immersed in the liquid beneath the main pump and has a shaft B which carries the rotor of the main pump. The axial thrust exerted on the shaft by the rotor

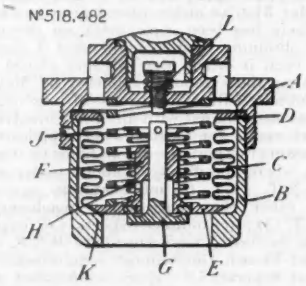


is counteracted by pressure exerted on the under side of a disc C, carried by the lower end of the shaft, by an auxiliary liquid within a casing D. Pressure is produced in the auxiliary liquid in the chamber E below the disc by means of an auxiliary pump F, part of the rotor of which may be constituted by the disc. Heat generated in the chamber is dissipated in the surrounding liquid to be pumped.—*February 27th*, 1940.

MISCELLANEOUS

518,482. July 25th, 1938.—VALVE FOR STEAM AND OTHER PRESSURE VESSELS, William Frederick Forrest Martin-Hurst, and the British Thermostat Company, Ltd., both of Teddington Works, Windmill Road, Sunbury-on-Thames, Middlesex.

This invention relates to relief valves for vacuum or pressure systems. Its object is to provide an improved construction capable of being employed in connection with pressure vessels which require protection from excessive stress such as might be caused by a rise of pressure or the production of a partial vacuum. In the drawing A is a hollow plug adapted to be screwed into a vessel, the interior of the plug being in permanent communication with the atmosphere through openings in the top. A hollow cylindrical body B containing a flexible metal bellows C is screwed into the plug. The upper end of the bellows is attached to an annular disc D in a recess in the body. The lower end of the bellows is attached to a movable disc E having a central opening which communicates with the interior of the bellows through a hollow guide sleeve F formed integrally with the movable disc. The opening in the disc E is controlled by a check valve G. The check valve has a stem which is guided in the sleeve and projects beyond the end as shown. A light coiled spring H surrounding the sleeve bears at one end against the disc E and at the other end against a disc or washer attached to the projecting end of the valve stem. A loading spring J compressed between the body A



and the movable disc tends to expand the bellows and to force the disc inwards relative to the steam or pressure vessel until it engages a stop consisting of an inturned flange K. The body carries an abutment in the form of a screw L projecting towards the stem of the check valve. This screw may be adjusted to regulate the degree of compression of the bellows necessary to cause the check valve to be opened. When the device is mounted in position, the outside of the bellows is exposed to the pressure inside the vessel and the inside of the bellows is exposed to the atmosphere. When these two pressures are equal the check valve is closed and the vessel is sealed. If a partial vacuum is produced in the vessel, the check valve opens automatically and allows air to enter the vessel. When the pressure rises above that of the atmosphere, the bellows is compressed so that the disc E moves upwards, carrying the check valve with it. When a predetermined difference of pressure is reached the stem of the valve comes into engagement with the abutment screw so that further compression of the bellows causes the valve to open and relieves the internal pressure.—*February 28th*, 1940.

518,694. September 3rd, 1938.—IMPROVEMENTS IN CHROMIUM SURFACE LAYERS ON CYLINDER BORES, Ingenieursbureau Lemet Chromium H. van der Horst, N. V., 11–13, Heerenstraat, Hilversum, Holland, and Henderik van der Horst, of the company's address.

According to the invention a layer of chromium is deposited electrolytically on the surface of a cylinder bore and the chromium layer is then treated for a short time with a reversed current so that the bore becomes the anode. The result of this treatment is that a certain amount of chromium is removed from the surface and numerous small grooves, pits, or depressions are formed in the surface. Under working conditions oil is retained in these depressions and there is no tendency for the chromium to pick up. The cylinder bore may be put into use in the condition in which it leaves the bath after treatment with reversed current or, if a smoother finish is required, the chromium layer may be lightly ground or honed. In this operation it is only the ridges or high parts between the depressions which are engaged by the grinding wheel or stones so that a minimum of chromium has to be removed. Where the bore is to be subsequently ground or honed the layer of chromium initially deposited on the bore is made slightly thicker than the required finished thickness. In a preferred method of carrying out the invention a layer of chromium of the desired thickness or of slightly more than the required thickness is deposited. The treatment of the chromium with reversed current may be carried out in the same bath as the deposition of the chromium but preferably it is carried out in a separate bath to avoid spoiling the solution. The solution in the second bath is preferably a chromic acid solution as used in the first bath, but various other acid or alkaline solutions such as a 20 per cent. caustic soda solution may be employed. Experiments have shown that a suitable surface can be obtained by treating a smooth chromium deposit with a reversed current of from 150 to 600 ampere-minutes per square decimetre. In addition to retaining oil the depressions reduce the effective area of the surface which is in contact with a piston and reduce friction. Further, the effective surface area facilitates any honing or grinding of the surface which may be subsequently carried out to bring it exactly to size as there is less chromium to remove.—March 5th, 1940.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Crewe Pupils and Premium Apprentices

Friday, May 24th.—Oddenino's Hotel, Regent Street, W.1. 50th Annual Dinner.

Faraday Society

Friday, May 17th.—Royal School of Mines, South Kensington, S.W.7. Discussion on "The Hydrogen Bond." 2.30 p.m.

CATALOGUES

DAVID BROWN AND SONS (HUDD), Ltd., Huddersfield.—Leaflet describing industrial spiral bevel gears.

HOPKINSONS, Ltd., Huddersfield.—Catalogue 920 of small steel valves, up to 1¼in. bore, for a wide variety of duties.

WELLWORTHY PISTON RINGS, Ltd., Lymington, Hants.—Pamphlet on high duty bearings in "Hiduminium" R.R. 101 material.

E. H. JONES (MACHINE TOOLS), Ltd., Edgware Road, The Hyde, London, N.W.9.—A leaflet describing the C.V.A. capstan lathe, and another the "Makonus" electric pencil.